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Economic Note

Employment, starting salaries, and educational indebtedness of 1989 graduates of US veterinary medical colleges

In cooperation with US colleges of veterinary medicine, the AVMA conducted its annual survey of the graduating classes of veterinary medicine in spring 1989. The primary purpose of the survey was to secure data on veterinary graduates' employment, salaries, and educational indebtedness. Of the 2,148 US graduates, 1,398 responded to the survey, a response rate of 65%.

Employment and income

At the time of the survey, 82% of the responding graduates had received at least one employment offer. Of those graduates receiving offers, 34% had received 1 offer, 26% had received 2 offers, and 40% had received 3 or more offers. At the time of the survey, 66% of the graduates had accepted positions for employment upon graduation.

Regarding the graduates who had accepted employment, 78% had accepted positions as employees in private practice (Table 1). Mean starting salaries are reported for 768 graduates who indicated annual starting salaries for full-time employment. For graduates taking positions as employees in private practice, the average starting salary was $24,742. This represents a 7.2% increase over the 1988 starting salary of $23,079 for private practice employees.[1]

The 1989 graduates chose employment in a variety of sectors of the veterinary medical industry, though the majority chose private practice as in past years (Table 1). Specifically, 39.1% entered small animal exclusive practice at a mean annual salary of $24,834, up 5.4% from 1988; 9.1% entered small animal predominant practice at a mean annual salary of $23,736, up 5.0% from 1988. Also, 11.8% entered mixed animal practice

Table 1—Types of employment and starting incomes of a large sample of 1989 US veterinary medical college graduates

	Percentage of graduates	Mean starting salary (No.)	Mean additional compensation expected in 1st year (No.)
Large animal exclusive	2.3	$25,210 (20)	$7,308 (12)
Large animal predominant	10.7	$26,663 (82)	$3,908 (64)
Mixed animal	11.8	$23,961 (96)	$3,488 (56)
Small animal predominant	9.1	$23,736 (64)	$3,248 (46)
Small animal exclusive	39.1	$24,834 (313)	$2,722 (201)
Equine predominant	4.8	$23,270 (38)	$6,456 (23)
University	1.3	$15,320 (11)	$1,250 (2)
Federal government*	0.8	$23,301 (5)	$1,000 (1)
Military service†	1.0	$31,275 (8)	$6,000 (1)
State/local government	0.1	$26,500 (1)	... ...
Industry/commercial	0.4	$29,000 (4)	$3,500 (2)
Advanced study	15.2	$16,363 (109)	$3,096 (26)
Self-employed	3.0	$26,000 (13)	$5,390 (10)
Other	0.5	$25,637 (4)	$2,000 (1)
	100 (924)‡	$23,627 (768)	$3,565 (445)

*Starting salary for federal government employment of veterinarians with no experience, no advanced degree other than the DVM, and not in the top 25% of their class was $23,846 (GS 9, step 1). †Starting salary for military employment for veterinarians who are single, with no prior military service, including base pay, subsistence and quarters allowance, and veterinary special pay was $28,290. ‡Of the 924 graduates reporting employment, 768 graduates reported their annual starting salary for full-time employment.

*Table 2—Distribution of 1989 US veterinary medical college graduates entering private practice according to starting salary**

Annual starting salary ($)	Relative frequency (%)	Cumulative frequency† (%)
Less than 15,000	2.0	100.0
15,001 to 19,000	2.9	98.0
19,001 to 23,000	25.9	95.1
23,001 to 27,000	45.0	69.2
27,001 to 31,000	20.1	24.2
More than 31,000	4.1	4.1

*Total respondents = 613. †Cumulative frequency percentages represent the percentage of graduates with annual starting salaries in excess of the corresponding next lowest salary interval; eg, 24.2% of the graduates reported salaries in excess of $27,000.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

Table 3—Percentage distribution of 1989 starting salaries of 768 US veterinary medical college graduates, by type of employment

Starting salary ($)	LAE	LAP	MA	SAP	SAE	EP	U	FG	MS	SLG	IC	AS	SE	Other
Less than 15,000	5.0	1.2	1.0	1.6	1.6	7.9	45.5	20.0	...	...	...	42.2	7.7	...
15,000 to 19,000	5.0	1.2	3.1	4.7	2.2	7.9	54.5	...	...	...	...	42.2	7.7	25.0
19,001 to 23,000	15.0	13.4	34.4	39.1	26.2	13.2	...	...	12.5	...	25.0	11.9	7.7	...
23,001 to 27,000	40.0	34.1	42.7	39.1	48.6	57.9	...	20.0	...	100.0	25.0	3.7	46.2	25.0
27,001 to 31,000	25.0	43.9	17.7	14.1	16.9	7.9	...	60.0	50.0	...	25.0	...	15.4	50.0
More than 31,000	10.0	6.1	1.0	1.6	4.5	5.3	...	...	37.5	...	25.0	...	15.4	...
No. of respondents	20	82	96	64	313	38	11	5	8	1	4	109	13	4

LAE = Large animal exclusive; LAP = Large animal predominant; MA = Mixed animal; SAP = Small animal predominant; SAE = Small animal exclusive; EP = Equine predominant; U = University; FG = Federal government; MS = Military Service; SLG = State/local government; IC = Industrial/commercial; AS = Advanced study; SE = Self-employed.

*Table 4—Educational debt of 1989 US veterinary medical college graduates**

Debt ($)	Relative frequency (%)	Cumulative frequency† (%)
0	17.6	100.0
1 to 5,000	6.0	82.2
5,001 to 10,000	7.1	76.4
10,001 to 15,000	5.9	69.3
15,001 to 20,000	9.9	63.4
20,001 to 25,000	10.7	53.5
25,001 to 30,000	13.1	42.8
30,001 to 35,000	7.4	29.7
35,001 to 40,000	8.9	22.3
40,001 to 45,000	4.9	13.4
45,001 to 50,000	3.7	8.5
More than 50,000	4.8	4.8

*Total respondents = 1,398. †Cumulative frequency percentages represent the percentage of graduates with debt in excess of the corresponding next lowest debt interval; 63.4% of the graduates reported debt in excess of $15,000.

at a mean annual salary of $23,961, up 7.5%. Only 4.8% of graduates entered equine practice, and the mean starting salary was $23,270, up 9.4%. In the livestock sector, 2.3% and 10.7% of graduates entered large animal exclusive and large animal predominant practice, respectively. In large animal exclusive and large animal predominant practice, mean starting salaries were $25,210, up 2.9%, and $26,663, up 14.8%, respectively. An additional 3.0% of the respondents reported that they would be self-employed in private practice, with an expected mean salary of $26,000.

As in past years, less than 2% of the responding graduates accepted positions with the military service. The mean starting salary was $31,275. Five respondents indicated employment with the federal government; their mean annual starting salary was $23,301. One respondent entering state/local government reported a salary of $26,500. Four graduates entering the industry sector reported a mean starting salary of $29,000.

In the academic sector, 1.3% took university positions (research or teaching) at a mean salary of $15,320, and 15.2% would begin advanced study (graduate degree, internship, or residency program) at a mean salary of $16,363.

The distribution of graduates entering private clinical practice who reported full-time employment salaries shows that 45% will earn between $23,000 and $27,000 in their first year of employment (Table 2). Twenty percent will earn between $27,000 and $31,000, and 4% will earn more than $31,000. Stated another way, almost one of four 1989 graduates entering private practice will earn an annual salary greater than $27,000 in their first full-time position. The percentage distribution across salary intervals is shown for all employment sectors in Table 3.

All graduates were asked if they would receive compensation in addition to their salary in their first year of employment. At least one half of the graduates who reported starting salaries indicated that they would receive additional compensation within the first year (Table 1). Most likely, the additional pay represents a percentage of gross income, a percentage of emergency fees, a bonus, a salary raise, or other financial compensation. Most graduates anticipating additional pay expected amounts ranging from $3,000 to $7,000.

Educational debt

All graduates were requested to indicate what their total educational indebtedness would be upon graduation. For the 1,152 graduates (82%) who indicated having educational debt, the mean debt was $27,726, up 7.7% from 1988. The relative frequency distribution showed that 63% of 1989 graduates, compared with 60% of 1988 graduates, had educational debt in excess of $15,000 (Table 4).[1]

Reference

1. Wise JK. Employment, starting salaries, and educational indebtedness of 1988 graduates of US veterinary medical colleges. *J Am Vet Med Assoc* 1988; 193:1317-1318.

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Economic Note

Employment of 1989 male and female graduates of US veterinary medical colleges

On the basis of the 1989 AVMA survey of 1,398 graduates of US veterinary medical colleges, it was estimated that 78% of the graduates accepted positions as private practice employees at a mean annual salary of $24,742.[1] This report describes in greater detail the employment choices of 1989 male and female veterinary medical college graduates.

Type of employment

Of the 1,398 graduates responding to the 1989 AVMA survey, 54% were women and 46% were men. Table 1 shows the proportion of graduates receiving offers of employment upon graduation. Excluding graduates entering advanced study programs (graduate degrees, internships, or residencies), 76% of the women received one or more offers of employment, compared with 89% of the men. The percentages are within 1 to 2 percentage points of those reported for 1988.[2]

Regarding graduates who had accepted employment (64%), 97% of the women and 99% of the men would work full time, whereas 3% of the women and 1% of the men would work part time. Of the 16 graduates indicating part-time employment, 11 (69%) were women, and 5 (31%) were men. In comparison with 1988, smaller percentages of women and men accepted part-time positions in 1989.

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*Table 1—Employment offers to male and female veterinary medical college graduates, 1989**

	Male (n = 568)	Female (n = 662)	Total (n = 1,230)
Received ≥ 1 offer (%)	89	76	82
Received no offers (%)	11	24	18

*Excludes graduates entering advanced study programs.

The distribution of female and male graduates was determined according to type of full-time employment (Table 2). Approximately 76% of female graduates accepting full-time employment took positions as employees in private practice. This compares with 80% of male graduates. About 17% of the women, compared with 13% of the men, began advanced study programs.

Starting salaries

Graduates were asked to report their starting salary (on an annual basis) for full-time employment. Table 3 shows that the female graduate's mean starting salary as a private practice employee was $23,944, up 5.9%

Table 2—Employment of male and female veterinary medical college graduates, 1989

	Male (n = 440)	Female (n = 377)
Large animal exclusive (%)	3.6	1.1
Large animal predominant (%)	16.8	3.4
Mixed animal (%)	12.3	12.5
Small animal predominant (%)	8.4	9.0
Small animal exclusive (%)	34.3	45.6
Equine predominant (%)	5.0	4.5
University (research, teaching; %)	1.6	0.8
Federal government (%)	0.5	1.1
Military service (%)	1.4	0.8
State/local government (%)	0.2	. . .
Industry/commercial business (%)	0.5	0.5
Advanced study (%)	13.2	17.2
Self-employed (%)	2.3	2.4
Other employment (%)	. . .	1.1

Table 3—Starting salary by type of practice for male and female veterinary medical college graduates, 1989

	Male	Female
Large animal exclusive	$26,856 (16)	$18,625 (4)
Large animal predominant	$26,947 (69)	$24,916 (12)
Mixed animal	$24,407 (52)	$23,434 (44)
Small animal predominant	$24,111 (34)	$23,310 (30)
Small animal exclusive	$25,387 (147)	$24,344 (168)
Equine predominant	$23,470 (21)	$23,035 (17)
All practice types	$25,377 (339)	$23,944 (273)

Figures in parentheses = No. of graduates reporting full-time employment and starting salary.

Table 4—Fringe benefits received by male and female full-time employed graduates, 1989

	Male (n = 440)	Female (n = 377)	Total (n = 817)
Life insurance (%)	24	22	23
Medical/hospital plan (%)	63	63	63
Dental plan (%)	10	10	10
Pension plan (%)	11	9	10
Profit-sharing plan (%)	17	14	16
Disability insurance (%)	36	28	32
Liability insurance (%)	64	60	62
Association dues (%)	48	45	46
Continuing education (%)	69	68	68
Annual vacation leave (%)	82	79	80
Sick leave (%)	49	43	46
Housing/apartment (%)	4	7	6

Table 5—Personal characteristics of male and female veterinary medical college graduates, 1989

	Male	Female	Total
Average age (yr)	27	28	28
Marital status			
Single (%)	57	66	62
Married (%)	41	29	34
Divorced (%)	2	5	4
Widowed (%)	<1	<1	<1
Graduates with children (%)	17	5	11

from 1988. The male graduate's mean starting salary as a private practice employee was $25,377, up 8.5% from 1988. The 1989 mean starting salary for females was $1,433 or 5.6% less than the 1989 mean starting salary for males.

The survey did not secure information on each graduate's responsibilities or hours worked in the new job. Thus, it is not possible to draw conclusions from these survey data about reasons associated with varying salaries between male and female graduates.

Fringe benefits

All graduates were asked to indicate which of 12 fringe benefits would be provided by their new employer. Of male and female graduates who accepted full-time employment, the percentage receiving each of the fringe benefits is in Table 4. The percentages of men and women receiving fringe benefits were similar, although for each fringe benefit, the percentage of men was equal to, or exceeded the percentage of women. Approximately 63% of women and men would be covered by a medical/hospital plan, at least 79% of women and men would receive annual vacation leave, 68% of women and 69% of men would have employer-paid continuing education expenses, and 60% of women and 64% of men would have employer-provided liability insurance. The percentage of men and women receiving fringe benefits increased from 1988.

Characteristics of graduates

Responding graduates provided information on personal characteristics such as age, marital status, and number of children (Table 5). The mean age of females was 28 years, and the mean age of males was 27 years. Regarding marital status, 66% of female graduates were single, 29% were married, and 5% were divorced. Of the male graduates, 57% were single, 41% were married, and 2% were divorced. About 5% of the women and 17% of the men had one or more children. These characteristics are nearly identical to those reported for 1988 graduates.

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Estimating income losses and other preventable costs caused by congenital toxoplasmosis in people in the United States

Tanya Roberts, PhD, and J. K. Frenkel, MD, PhD

Previous estimates of costs of congenital toxoplasmosis in the United States have focused on medical expenses and special education or residential care for visually impaired and mentally retarded survivors.[1,2] In the United States, costs have not been estimated for income losses for fetuses or infants who become mentally retarded and have reduced lifetime income or who die as a result of congenital toxoplasmosis. In the United Kingdom, research workers have included these income losses in their estimates of the cost of toxoplasmosis.[3]

Estimated number of annual cases

Reported annual estimates of congenital toxoplasmosis in the United States[4-7] differ because studies have examined different parts of the US population and exposure to *Toxoplasma gondii* may vary. Differences in exposure may take place because of cultural food preparation habits that encourage contact with raw pork or consumption of rare pork. Most cases are thought to result from handling raw meat or eating undercooked pork and, to a lesser extent, mutton, venison, beef, and chicken. There also are differences in climate affecting organism survival or differences in contact with cats or soil contaminated with cat feces.

The probability of maternal and fetal infection depends on the time at which infection develops in the pregnancy.[8,9] Even if exposure and maternal and fetal infection rates were identical, research workers may find different infection rates because they use serotests that differ in their sensitivity and specificity to determine the presence of *T gondii* infection.[10,11] Another factor may be changes in exposure over time because of the increasing use of preventive actions (washing hands after contact with raw meat, garden soil, or cat litter and before eating) by pregnant women to reduce exposure, food manufacturer's increased freezing of meat, which kills most cysts; increasing use of swine confinement pens that may limit cat access and reduce disease transmission to swine; or changing patterns of cat ownership and cats' diet.[12]

Table 1—Calculation of regional and national Toxoplasma *exposure in human beings*

Region	Regional exposure (%)	Share of population (%)	Contribution to US exposure (%)
Northeast	20	5.27	1.05
Mid Atlantic	16	15.48	2.48
East north central	18	17.30	3.11
West north central	12	7.30	0.88
South Atlantic	18	16.97	3.05
East south central	19	6.31	1.20
West south central	13	11.16	1.45
Mountain	3	5.39	0.16
Pacific	8	14.81	1.19
Total	...	100	14.60

Exposure data based on 17- to 23-year-old recruits[5] and population data.[15]

Because of the uncertainty associated with estimating the number of maternal and fetal infections, 2 methods are used to develop estimates. One approach examines possible maternal exposure and the likelihood of transmission to the fetus to estimate congenital exposure. Nationwide exposure data are sketchy. Data from Sever et al[13] are not used because of the lack of systematic follow-up examination of the babies to verify how many were really infected with *Toxoplasma*. The most extensive data on geographic variation in exposure come from a survey of military recruits.[5] Feldman[5] estimated the cumulative exposure for 17- to 23-year-old recruits in various states and combined data into regional exposure rates that range from 3 to 20%. Weighing these rates by current regional population yielded a national average exposure of 14.6% (Table 1). Assuming pregnant women have similar exposure patterns, the national average cumulative exposure for pregnant women would be similar (14 to 15%).

Using cumulative exposure data, Frenkel[1] estimated annual seroconversion rates indicating annual exposure. The 14 to 15% cumulative exposure rate for 17- to 23-year-olds translates to an annual seroconversion rate of 0.5 to 1%, depend-

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Table 2—Estimated number of annual fetal infections as a function of maternal infection and the maternal/fetal transmission rate in human beings

Maternal/fetal transmission rate (%)	Maternal seroconversion rate	
	0.5%	1%
30	4,200	8,400
45	6,300	12,600
60	8,400	16,800

Mean (rounded to nearest 100) is 9,500 cases/yr

ing on how one adjusts for the relative lack of exposure before the ages of 5 to 10 in the United States. Contrary to data from Central America, where *Toxoplasma* infection is actively acquired during early childhood,[14] transmission in the United States starts later.[15] Therefore, the prevalence rates for 20-year-olds cannot be interpolated to 0% at birth, but are more likely to be 0% between ages 5 and 10. The total number of maternal exposures each year is then estimated by multiplying the annual 3.7 million live births[16] times the annual maternal seroconversion rate times 9/12 (portion of the year a woman is pregnant). With a seroconversion rate of 0.5%, total estimated maternal exposures are 14,000/yr. With a seroconversion rate of 1%, twice as many maternal exposures take place (28,000/yr).

However, not all maternal exposures are transmitted to the fetus. The range varies from a fetal exposure 33% of the time[9] to 61%.[8] In one study,[9] some mothers were treated with spiramycin, reducing the rate of transmission to the fetus. However, both estimates reveal how the estimated number of annual congenital infections varies with the maternal infection rate and the maternal/fetal transmission rate (Table 2). Estimates of fetal infections range from 4,200 to 16,800 cases/yr. Assuming each estimate has an equal probability of occurring, a reasonable population estimate is the simple average of all 4 estimates, or 9,500 congenital infections.

Another approach to estimating the number of infections is based on serotests of blood samples from newborns. In Massachusetts,[a] capillary blood was collected from newborns (usually 3 days old) and examined for IgM *Toxoplasma* antibodies. The Massachusetts data could represent an area of the United States with a relatively high incidence rate. However, the maternal prevalence in a substudy of the Massachusetts study was 14%, which is quite similar to the US incidence (Table 1). Preliminary findings indicated *Toxoplasma* antibodies, and therefore infection, in only 1 in 10,000 babies. This estimate is increased by 10% to account for the possibility that the IgM test used was not as sensitive as the IgA test. Multiplying this estimate by the live-birth rate in the United States of 3.7 million/yr[16] results in an estimated 407 cases of congenital toxoplasmosis/yr.

However, only paired testing for IgA and IgM can verify these assumed differences in test sensitivity. The sensitivity of the IgM test Hoff[a] used was greater than the IgM test used by Decoster et al,[10] although the difference has not been determined concretely. For the 26 infants whose mothers were infected during pregnancy,[10] IgA antibodies were detected in 8, although only 3 infants also had IgM antibodies. This fact may indicate that the IgA test is more sensitive by a ratio of 8:3 (2.67) and may indicate that the Hoff findings[a] could be doubled. However, the Decoster et al[10] findings are complicated by inclusion of some older babies in whom IgM titers may have decayed.

In the 1960s, 1 of 486 babies had increased IgM values in serum obtained from umbilical cord, indicating *Toxoplasma* exposure.[17] In the next year, the incidence was 1 of 1,500, for a mean incidence over the 2 years of 1 of 1,000. In the 1980s, the incidence declined to 1 of 10,000.[b] Although these 2 methods of computing the likely toxoplasmosis infections produce different results (407 vs 9,500 estimated infections), the range cannot be narrowed until national screening serotests are conducted.

Effects of congenital toxoplasmosis

Consequences of *T gondii* infection in fetuses and newborns can only be estimated by prospective studies in which asymptomatic infants and infants with symptoms of illness are monitored. Otherwise, mild or subclinical cases will be missed and only severe cases will be estimated. The largest prospective study was conducted in France, where newborns are routinely tested for *Toxoplasma* antibodies indicating exposure.[18] To adapt the French study to the United States, only data for nontreated maternal infections were used. In the United States, most maternal infections are asymptomatic or undiagnosed.[2,19] In France and Austria, testing for *Toxoplasma* during pregnancy is mandatory, but the low incidence of infection in the United States results in only sporadic testing of a small fraction of pregnant women. Few adults with toxoplasmosis seek treatment for the mild symptoms. In one study,[20] only one person sought treatment for a high fever and headache, although in a subsequent epidemiologic investigation, 36 others had high titers indicating *Toxoplasma* exposure. Therefore, only 1 of 37 persons sought medical attention for symptoms of infection. A collaborative study in the United States to determine consequences of infection and optimal treatment is just being started.

For fetal exposure, 2% of infants die[18]; this is a doubling of deaths to account for the underreporting in that study, because infants who had already died were not part of the study (Table 3).

---

[a] Hoff R, State Laboratory Institute, Massachusetts Department of Health, Boston, Mass: Personal communication, 1989.

[b] Alford CA, Department of Pediatrics and Clinical Pathology, University of Alabama Medical Center, Birmingham, Ala: Personal communication, 1989.

Spontaneous abortions[21] were left out of estimated cases because adequate data were not available.

Most studies[22,23] are based on clinically selected cases that emphasize the severe and overlook the mild cases that are better represented in prospective studies. Later sequelae of congenital toxoplasmosis have been studied prospectively[24] in children until age 11 to 21 years. The most common consequences were severe mental retardation in 20% of cases, moderate visual impairment, 20%; strabismus or cross-eyed vision, 13%; slight mental retardation, 12%; moderate hearing loss in one ear, 10%; and moderate mental retardation, 9% (Table 3).

Table 3—Impairments caused by congenital toxoplasmosis in human beings

Impairment	Percentage First year[18]	 Additional in second year[18]	 3 to 17 years[24]†	Total affected (%)
Death	2	0	0	2
Severe illness	11	0	0	11
Severe retardation	11	+2	+20	33
Moderate retardation	5	+3	+9	17
Slight retardation	5	+6	+12	23
Blindness (bilateral)	6	0	+2	8
Moderate visual impairment	16	+17	+20	53
Strabismus	5	+2	+13	20
Deafness	2	0	0	2
Hearing loss (moderate unilateral)	0	0	+10	10
Normal	55*	36*	20*	20*

*After 20 years. †A few lesions were present at the time of the first visit. Some original percentages were increased based on clinical and epidemiologic suspicions, given the rarity of making a diagnosis in the United States outside of specialty medical centers: severe retardation was increased from 8 to 20%, moderate retardation was increased from 8 to 9%, and bilateral and unilateral blindnesses were combined for a 2% estimate.

Deafness varied widely from 0 to 13%.

Estimated economic costs

Three types of costs were estimated: income losses because of impairment or death, reducing the potential labor market participation and/or income of affected individuals; medical costs incurred from infancy through adulthood; and special education costs or residential care required because of a handicap caused by congenital toxoplasmosis.

Lost income—Income losses because of impairment or death are unemployment, working in a lower-skill job for lower pay than an unimpaired individual, or death.

Valuing the loss of an infant's life to society is a subjective issue. Is the loss of a fetus valued less than that of an infant who lives for a short time? If the fetus or infant dies, how often will it be replaced by another pregnancy? Parents could be considered to value a child at least as much as they would pay to raise the child. Or we could consider that if the fetus or infant had lived, an average work history would have occurred and the income loss is equal to a lifetime of production or income. This option of valuing lifetime income, called the human capital method, is the economists' traditional method for valuing a shortened life. The lifetime stream of income is converted to a present-day value by discounting future income to its worth today, given today's real rate of interest. The most recently suggested method[25] estimates what people will pay to reduce risks to life; these willingness to pay estimates are the highest of all.

The present value of income losses were estimated, using a modified traditional human capital equation,[26] which defines income more broadly and adds a risk aversion factor:

$$\begin{array}{l}\text{Present value}\\ \text{of reducing}\\ \text{risks to life}\end{array} = \left[\sum_{t=0}^{T} \frac{Y_t}{(1+r)^t}\right]\alpha$$

Income, Y, is after-tax labor and nonlabor income (measured in constant dollars so inflation is taken out of the estimates) as well as home-produced good and services, such as meals. T is time or the person's remaining lifetime. A specific year is t. The real rate of interest, r, used to discount future income to today's value, is 3%/yr. Again, the interest rate does not include inflation. A 3% discount rate represents a household's real rate of return on investment. Consensus is that the US government's opportunity cost of capital is the international real rate of interest. Rates of 2 to 4% have been discussed and explicitly mentioned as rates that should be used in benefit/cost analysis.[c]

The addition of the risk aversion factor, α, is based on data on life insurance purchases that reveal people with life insurance pay 60% extra in premiums over the probable lifetime income loss. This extra payment represents the relationship between the willingness to pay for reduced risk (the outlay for insurance) and the expected benefits of the insurance (the probability of a loss multiplied by the value of the asset in question). The extra 60% reflects the risk aversion benefit of protecting a household income. All t variables in the equation are derived from market valuation of goods and services produced or purchased during one's lifetime. Updated to 1989 dollars,[27] (using the increase in the average weekly earnings for production workers reported by the Bureau of Labor Statistics) the estimated present value of an infant's life is $983,000.

Norwegian data[28] have been evaluated for the likelihood that a stillbirth or infant death will be replaced by another pregnancy. Although the likelihood varies by maternal age, on average, a replacement child is conceived 60% of the time. We assume that families in the United States respond similarly. Thus, for fetal or infant deaths, we assume that 60% of the deaths will be replaced by siblings who fully compensate for the earlier loss and that 40% will not be replaced. In other words,

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[c] Allied Social Sciences Association, New York, NY: Unpublished data, 1989.

Table 4—Effect of retardation on employment and loss of income[31]

Degree of retardation	Men (%) Working	Men (%) Income compared with US average	Men (%) Not working	Men (%) Total loss*	Women (%) Working	Women (%) Income compared with US average	Women (%) Not working	Women (%) Total loss*
Slight (IQ 50 to 69)	87	86	4	18	33	87	12	36
Moderate (IQ 40 to 49)	45	19	46	91	12	19	33	95
Severe (IQ <40)	0	0	100	100	0	0	100	100

*The total loss in income of the retarded group is the loss of the income for those retardates not able to work plus the reduced income of working retardates. The equation: Total percentage of loss = [(percentage of retardates not working/percentage working in general population) × 100%] + [(percentage of retardates working/percentage working in general population) × (1-percentage of income)].

In this data set, 91% of men and 45% of the women in the general population were working.

for the fetal or infant death category, cases are valued at 40% of the income loss. Emotional cost of losing a fetus or baby,[29,30] the maternal cost of being hospitalized for a stillbirth or subsequent infant death, and the cost of a delay in having a replacement child are all omitted from the estimates. In some cases, these costs may be important.

In an exhaustive study[31] of costs of mental retardation in the United States in 1973, slightly retarded adults (IQ, 50 to 70) were able to find jobs at wages close to the average income of the general population (Table 4). Moderately retarded persons (IQ, 40 to 49) frequently found jobs, but their wages were only 19% of the average. Few retardates with IQs below 40 were employed. Combining the income loss as a result of lower wages and the loss as a result of greater unemployment, we have calculated the total income loss for slightly retarded men at 18%, for slightly retarded women at 36%, for moderately retarded men at 91%, for moderately retarded women at 95%, and for the severely retarded of both genders at 100%.

Effects of mental retardation on income have been estimated[3] (Table 5). Data assumed the severely retarded would not be employable and would have a 100% income loss. For the moderately retarded group, a 67% income loss, was assumed,[3] whereas another analysis[31] revealed > 90% income loss. For the slightly retarded, women's reduced incomes were comparable in both estimates, but for men, Conley[31] estimated only an 18% income loss, which is less than the 33% reported elsewhere.[3]

Other data are available for those mentally retarded individuals, exiting state/federal programs of vocational rehabilitation.[d] In 1983, 26,000 retardates successfully completed rehabilitation services. Data for those entering the program revealed 92 to 93% of retardates at all 3 degrees of retardation were unemployed and most were under 25 years old. On completion of the program, 93 to 94% (at all 3 degrees of retardation) entered the paid labor force, although placement in sheltered workshops increased dramatically as the degree of retardation increased. The income profile is flatter for this data set than for the others: for the slightly retarded, income loss was 49% of the median weekly income of the general population; for the moderately retarded, income loss was 63%; and the severely retarded had a 79% earning loss.

Degrees of retardation used in the Department of Education's retraining program are a combination of IQ and behavior and are not strictly comparable with categories[31] based only on IQ. Earnings of people exiting training are compared with earnings of the younger members of the labor force, which are 67% of the median weekly earnings.[16]

Table 5—Comparison of studies on estimated income reduction (%) because of mental retardation

Retardation	Group A[3]	Group B[31] Men	Group B[31] Women	Group C[e]	Group D[d]	Group E[42,*]
Slight	33	18	36	27	49	10 to 50
Moderate	67	91	95	93	63	...
Severe	100	100	100	100	79	...

*For small deviations around the mean IQ (ie, 100), the authors concluded that a 1% decrease in IQ has been associated with around a 1% decrease in income, with the range between 0.24% and 1.25%.[42] For a reduction in IQ of 40 points (slight retardation), this translates to a decrease in income of 10 to 50% that brackets other estimates of income loss. The 40-point change is relatively large and may be stretching the analysis to extrapolate the income change this far.

Group-C data are an adaptation of the group-B data, in which babies with congenital toxoplasmosis are assumed to be equally allocated between genders.

Table 6—Income losses for deaths and impaired survivors (low estimate assuming 407 congenital cases annually and high estimate assuming 9,500 cases)

Outcomes	Income loss/case ($)*	No. of cases Low	No. of cases High	Total (million $) Low	Total (million $) High
Fetal/perinatal deaths†	393,200	8	190	3.1	74.7
Severely retarded	983,000	134	3,135	131.7	3,081.7
Moderately retarded	914,200	69	1,615	63.1	1,476.4
Slightly retarded	265,400	94	2,185	24.9	579.9
Blind	688,100	33	760	22.7	523.0
Deaf	550,500	8	190	4.4	104.6
Total loss	...	...	...	249.9	5,840.3

*The income loss for deaths is 40%, because 40% of infants are not replaced by another birth. The income loss is 100% for the severely retarded because they do not work. The income loss for the moderately retarded is 93%, the slightly retarded 27%, the blind 70%, and the deaf 56%, reflecting their average income compared to the average US population. †Newborn deaths, stillbirths, and fetal losses are assumed to be replaced by another child 60% of the time. If only 50% are replaced, the estimated fetal/perinatal loss would be increased to $4.1 to $99.6 million. If 70% are replaced, the estimate would be decreased to $2.5 to $59.8 million.

Income losses are not adjusted for double counting because cases falling into 2 categories are likely to be penalized for both disabilities.

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[d] Mars L, Rehabilitation Services Administration, US Department of Education, Washington, DC: Unpublished data, 1989.

Table 7—Special education and residential care costs for mentally retarded people

Congenital toxoplasmosis outcomes	Present value of costs/case ($)*	No. of cases		Total costs (million $)	
		Low	High	Low	High
Severely retarded (40-year life-span)					
Residential care	1,030,000	67	1,568	69.0	1,615.0
Live at home for school years†	109,000	67	1,568	7.3	170.9
and in institution	10,900	...	...	0.7	17.1
after age 18	417,142	...	...	27.9	654.1
Moderately retarded	77,000	69	1,615	5.3	124.4
Slightly retarded	43,000	94	2,185	4.0	94.0
Blind					
Special education	161,000	33	760	5.3	122.4
Additional family expense	161,000			0.5	12.2
Deaf					
Special education	113,500	8	190	0.9	21.6
Additional family expense	11,350		...	0.1	2.2
Total		338	7,886	115.7	2,833.9

*All costs are discounted by a 3% annual interest rate to arrive at a present value. †The top figure is the cost of schooling for the first 18 years at home, the second number is 10% extra for the family's additional expenses, and the third number is the cost of residential care after age 18.

All blind and deaf children are assumed to live at home instead of the more expensive residential care. This conservative assumption is made to offset any double counting that may occur because of multiple handicaps.

Average earnings for the retrained in 1983 were $108.10 for the mildly affected group, $78.7 for the moderately affected group, and $44.40 for the severely affected group.[d]

Self-selection of people entering training programs may explain much of the difference from Conley's data:[31] slightly retarded persons may be able to find jobs on their own, those who are less capable enter federal job training, and the most severely retarded may not apply for or be selected for federal job training. The youthfullness of the groups may also be important. Still, the range of income losses is close to other estimates.[3,31] Because Conley's data[31] are the most comprehensive, his data on reduced income were used for the estimated income losses caused by mental retardation (Table 6).

For income losses caused by other impairments, a study at Rutgers was used.[32] The income loss of persons with visual impairment was 70%, and the hearing impaired had a 56% income loss (Table 6). Because of the small number of people with these impairments, adding these income losses did not increase the estimates. Most income loss is a result of severe or moderate mental retardation. The large range in the estimates, from $0.2 to 5.8 billion, is a result of different estimates of the number of cases of congenital toxoplasmosis each year.

Costs of special education and residential care—Half of the severely retarded are assumed to be living in institutions and the other half to be living at home.[3] The annual average expenditure for public education was $3,970[16]/student in public school in 1987. Because 88% of children in the United States are in public schools, $3,970 was used as the baseline cost. One study[33] calculated the additional cost of educating persons with various disabilities. For educable mental retardates, the additional cost was 1.30 times the cost of regular education, (1.30 × $3,970 = $5,160/yr). For trainable retardates, the additional cost was 2.34 times the cost of regular education (2.34 × $3,970 = $9,290/yr). For the severely retarded, the additional cost was 2.59 times the cost of regular education (2.59 × $3,970 = $10,280/yr). Assume 12 years of education plus an additional 3 years of preschool for the severely retarded.[2] For residential cases, costs were assumed to be the average fee of $122/day for a mentally retarded person in a residential facility.[16] For the severely retarded living at home, and extra 10% was added to the education costs for additional home expenses.[3] All costs are discounted by a 3% real rate of interest to arrive at a present-day value.

Additional education costs for children who are deaf or blind are greater than for the severely mentally retarded: 3.43 and 4.86 times the average cost, respectively, for estimates of $13,617 and $19,294/yr, respectively. A 10% additional fee is added for a family's extra expenses, and the costs are discounted. The severely retarded dominate the estimates, largely because of the high cost of residential care. The range of total costs is $116 million to $2.8 billion (Table 7).

Medical costs—Medical costs are incurred by those ill as infants and those with visual impairment. For the 2% of infants who die, we assumed 3 weeks of intensive-care hospitalization at $1,000/d[34] and an equal amount for physician services, tests, and drug treatment,[35] for a cost of $42,000/case (Table 8). For the 11% of infants who survive severe illness, we assumed 2 weeks in intensive care at $1,000/d and 2 weeks in a regular hospital room at $500/d,[34] plus a fee equal to hospital costs for physician services, tests, and drug treatment[35] resulting in a cost of $42,000/case.

Because most children with *Toxoplasma* antibodies develop sequelae (Table 2), diagnostic tests to determine the cause of the clinical signs are re-

Table 8—Medical costs for congenital toxoplasmosis cases in human beings[e]

Outcomes	Cost/case ($)	No. of cases		Total costs (million $)	
		Low	High	Low	High
Severe neonatal illness					
Deaths	42,000	8	190	0.3	8.0
Survivors	42,000	45	1,045	1.9	43.9
Diagnostic tests*	2,500	407	9,500	1.0	23.8
Yearly eye examination†	1,041	216	5,035	0.2	5.2
Strabismus‡	400	81	1,900		0.8
Total				2.4	57.9

*Each diagnostic work-up could cost around $2,000 to 3,000 (not discounted because most tests follow symptom development in first or second year of life). †Discounted at 3% annual interest to compute a present value. ‡Not discounted because of uncertainty over what year the operation would occur.

No estimate is made for the testing and physician time to diagnose congenital toxoplasmosis.

Table 9—Summary of preventable costs for congenital toxoplasmosis in human beings

Cost category	Estimate (million $)	
	Low	High
Income loss	250	5,840
Special education/residential care	116	2,834
Medical costs	3	82
Total	369	8,756

Costs are discounted at 3%/yr.

quired. Generally these tests follow symptom development and are done in the first year or 2 of life. The estimated cost is $2,000 to $3,000/child.[e]

Those with visual impairment (48%) were assumed to have an annual eye examination for 20 years at cost of $70/examination.[f] Of these individuals, 17% were assumed to need an operation for strabismus (cross-eyed vision) at a cost of $400.[e] These medical costs for visual sequelae are small compared with the illness costs of hospitalized infants. The total medical costs are estimated to be $2.5 to 59 million (Table 8).

Of the 3 types of preventable costs estimated, income loss is two-thirds of the total cost (Table 9). The largest contributors to income loss are people who are severely or moderately retarded. Next in importance are special education and residential care costs. Medical costs comprise a small part of the estimated preventable losses. The range of total preventable cost estimates is from $368 million to $8.7 billion for the infants estimated to be born each year with congenital toxoplasmosis.

We believe the wide range in the estimates is caused by the great uncertainty over the actual number of cases. For social and economic reasons the incidence of toxoplasmosis in the United States may be declining and the order of magnitude of the lower estimate may be more accurate.

Finally, estimates do not include costs of toxoplasmosis to adults. Recrudescent toxoplasmosis has appeared in patients treated because of neoplasms and organ transplants, and in patients with acquired immune deficiency syndrome.

Discussion

Previous estimates have used different procedures or estimated different costs (Table 10). Lifetime costs[2] of special services for 3,300 children with congenital toxoplasmosis in the United States were estimated at $222 million in 1978. These figures did not include deaths, estimate income losses, or discount costs to compute a present value (which overstated costs), but did include a transfer payment of aid to the totally disabled that most economists would not include.

In the United Kingdom,[3] the greatest loss was a result of income loss and residential care for the moderately mentally retarded. Income loss is more narrowly defined than in the Landefeld and Seskin[26] measure used in this study. Costs are given in 1980 English pounds and are discounted at 5% to compute a present value. Over time, as cases of congenital toxoplasmosis in the United States are identified more quickly and treatment is started sooner, the incidence of sequelae can be expected to decline.

None of the studies,[2,3,31] including the present study, estimated psychological costs because of family disruption and the stress of having a mentally retarded child; nor did they place a value on the fact that the mentally retarded have fewer friends and are less likely to marry than are persons with an average IQ[31,36,37] (Table 10).

The wide range in the Roberts and Frenkel estimates reported here is a result of the great uncertainty over the number of infected babies. The difference in the estimated cases using information from mothers vs newborns may be partly a result of comparing data from people a generation apart. If the incidence of toxoplasmosis is declining, much of the accumulated incidence in the mothers reflects outdated socioeconomic circumstances, whereas data from recent newborns reflects recent socioeconomic factors (freezing of meat, changes in swine rearing, changes in cat ownership and diet, and greater handwashing after contact with raw meat) that cause a lower exposure rate.

Although routine testing of newborns would give us more data on today's actual incidence, establishing such a system nationwide should not be done without careful consideration of costs and the low incidence of infection. The predictive value of tests is a function of the incidence as well as the test sensitivity and specificity. We are accustomed to using the predictive values of tests in a clinical setting when cases are concentrated to between 1:10 (1 case/10 patients) and 1:100. However, when dealing with population surveys and a lower incidence of 1:1,000 or 1:10,000, as discussed here, the predictive value of even a sensitive and specific test drops to approximately zero.[38]

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[e] Cho C, University of Kansas Medical Center, Kansas City, Kan: Personal communication, 1989.

[f] Godfrey W, University of Kansas Medical Center, Kansas City, Kan: Personal communication, 1989.

Table 10—Comparison of toxoplasmosis cost studies

Item	United States[7]	United Kingdom[3]	United States
Cases			
No. of congenital cases	3,300	195 to 585 to 1,950	407 to 9,500
Cases/1,000 live births	1.1/1,000	0.3/1,000 to 0.9/1,000 to 3/1,000	0.11/1,000 to 2.6/1,000
Assumed maternal/fetal transmission (%)	45	39	30 to 60; average, 45
Cost estimates			
Year	1978	1980	1987 to 1989
Annual discount rate	None used	5%	3%
Deaths (infant/fetal)	NE	8% of cases	2% of cases
Medical costs	NE	4 days in hospital	3 weeks of intensive care
Income loss	NE	NE	40% of lifetime income*
Severe illness at birth	8% of cases	10% of cases	11% of cases
Medical costs	NE	4 weeks in hospital	2 weeks intensive care and 2 weeks regular hospitalization
Mental retardation			
Severely retarded	15.1% of cases	5% of cases	33% of cases
Residential care	40 years	½ for 10 years	⅓ for 40 years
Special education		½ for 6 years	⅔ for 15 years/live at home
Extra family expenses	None	£15/week†	10% of special education cost
Income loss	NE	Total loss‖	Total loss‖
Moderately retarded	7.1% of cases	5% of cases	17% of cases
Special education	15 years	Primary and secondary	12 years
Extra family expenses	NE	£15/week†	NE
Income loss	2.4% unable to work (valued at disability payment for 44 weeks)	⅔ of lifetime income	93% of lifetime income
Slightly retarded	None	5% of cases	23% of cases
Special education		Primary and secondary	12 years
Income loss		⅓ of lifetime income	27% of lifetime income
Deafness	NE	NE	2% of cases
Special education	NE	NE	12 years
Extra family expenses	NE	NE	10% of special education costs
Income loss	NE	NE	56% of lifetime income
Visual Problems			
Special education for visually handicapped	14.2% for 10 years		NE
Blind	§	1% (adjusted to avoid double-counting with moderately retarded)	8% of cases
Special education		‡	12 years
Extra family expenses		NE	10% of special education costs
Income loss		50% of lifetime income	70% of lifetime income
Yearly ophthalmologic follow-up care	78% for 20 years	20% for 6 years	53% for 20 years @ $70/examination
Operation for strabismus	NE	46%	20% of cases @ $400

*Psychic loss to family is not estimated. †November 1980 price values. ‡Assumed ⅓ would be in residential care from 0 to 14 years of age and the rest would have extra costs for special education. §Included in severely retarded category. ‖Of lifetime income.
NE = none estimated.

For benefit/cost studies, the relative cost of several proposals should be kept in mind. Four principal methods of preventing toxoplasmosis have been described: (1) repeated serologic screening during pregnancy, when necessary aided by amniocentesis, examination of fetal blood (culture and serologic) and ultrasonic examination, with chemotherapy/chemoprophylaxis and therapeutic/prophylactic abortion of fetuses believed or proven to be infected[2,39]; (2) serologic screening of newborns at the time of delivery,[40] together with testing for phenylketonuria and congenital hypothroidism, with treatment of newborns found to be infected, as practiced by Hoff[a]; (3) prevention of maternal infection by education on hygiene, stressing hand washing and adequate cooking of meat; and (4) controlling transmission of toxoplasmosis by cats, by vaccination combined with control of stray cats and of some intermediate hosts,[41] and in some circumstances vaccination of women of childbearing age who are likely to be exposed to *Toxoplasma*. The 4 strategies are compatible with one another, and all will probably come into use gradually over time. Still, if the expenditure of public funds were proposed in support of any of these approaches, cost-efficiency calculations would be desirable.

Although exact estimates depend on details of implementation of these proposed strategies, a tentative ranking of costs for the programs can be made on the basis of their relative complexity and labor intensiveness. In these terms, the cost would probably be stratified as 1 > 2 > 3 (multiple serologic, microbiologic, ultrasound examination during pregnancy > single serologic examination at birth > maternal education). The cost of the control of toxoplasmosis by vaccination of cats, and perhaps human beings, and other measures is still unknown and depends on the outcome of laboratory and field trials and on the cost of vaccine production and distribution.

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Economic Note

Trend in real starting salaries of US veterinary medical college graduates, 1980-1989

Table 1—Real starting salaries of US veterinary medical graduates, 1980-1989

	Money income ($)				Real income (1983 dollars)			
Year	Private practice	Nonprivate practice	Advanced study	All graduates	Private practice	Nonprivate practice	Advanced study	All graduates
1980	18,552	17,967	12,033	17,175	22,433	21,725	14,550	20,768
1981	18,832	18,059	12,937	18,314	20,626	19,780	14,170	20,059
1982	19,351	20,864	13,781	18,700	19,970	21,531	14,222	19,298
1983	19,872	22,865	13,541	19,194	19,872	22,865	13,541	19,194
1984	20,237	21,493	13,797	19,527	19,403	20,607	13,228	18,722
1985	20,956	21,814	14,199	20,164	19,405	20,199	13,148	18,672
1986	21,205	22,027	15,186	20,478	19,275	20,022	13,804	18,615
1987	22,152	25,697	15,272	21,693	19,427	22,536	13,394	19,025
1988	23,079	25,832	15,766	22,181	19,455	21,776	13,291	18,699
1989	24,742	23,645*	16,363	23,627	19,959	19,074	13,200	19,060†

*Includes graduates who indicated university employment but who may, in fact, be pursuing advanced study. †Based on projected 4.4% increase in cost of living for 1989.

Mean starting salaries of US veterinary medical graduates have been reported annually since 1980.[1-3] The mean starting salary increased 29.1% from $17,175 in 1980 to $22,181 in 1988 (Table 1). This represents a compounded annual growth rate of 3.2%. The 1989 mean starting salary was $23,627, up 6.5% from 1988.

These data show that graduates' starting salaries have risen in money terms. In real terms, ie, correcting for the increased cost of living, graduates' mean starting salary declined. The most widely used measure of the change in the cost of living at the retail level is the Consumer Price Index for all urban consumers. The Consumer Price Index increased 49.9% from 1980 to 1989. This compares with the 37.6% increase in all graduates' mean starting salary from 1980 to 1989.

Analysis of graduates' starting salaries in real terms was accomplished by expressing the mean starting salary for each type of employer for each year, 1980 through 1989, in 1983 dollars. Table 1 shows mean starting salaries in money terms and real terms (1983 dollars).

Results show that in real terms, graduates' mean starting salary declined 10%, from $20,768 in 1980 to $18,699 in 1988, but increased by 1.9% from 1988 to 1989. Overall, the trend in real starting salaries has been flat since 1984. Current graduates have neither gained nor lost notable purchasing power relative to 1984 graduates.

For the years 1986 to 1989, analysis focused on money incomes of male and female graduates entering full-time employment in private clinical practice. Mean starting incomes of male graduates have increased 17.6% from $21,576 in 1986 to $25,377 in 1989. Mean starting incomes of female graduates have increased 16.4% from $20,577 in 1986 to $23,944 in 1989. Figure 1 shows the trend in male and female graduates' mean starting salaries. In every year since 1986, male starting salaries have, on average, exceeded female starting salaries in private practice employment. Interestingly, since 1987, the amount by which the mean starting income of male graduates exceeded the mean starting income of female graduates increased from $236 in 1987, to

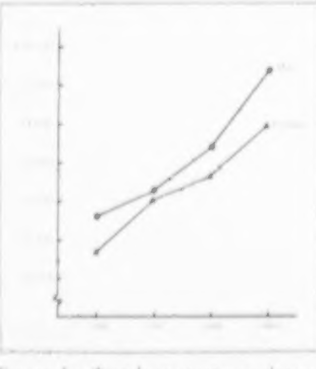

Figure 1—Trends in starting salaries of male and female veterinary medical college graduates entering private clinical practice.

Prepared by J. Karl Wise, PhD, Wisemark Associates, PO Box 681189, Schaumburg, IL 60168-1189.

$780 in 1988, to $1,433 in 1989.

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Book Review: Diagnostic Cytology of the Dog and Cat

The excellent, comprehensive presentation of cytologic sampling techniques, color photomicrographs, and substantial supporting text make *Diagnostic Cytology of the Dog and Cat* a definitive reference work for the student and experienced veterinary cytologist alike.

The first chapter is an in-depth review of cytologic techniques and terminology. The descriptions are clear and appropriately detailed. The authors discuss problems that arise with poor collection technique, poor slide making, and poor staining.

The focus of staining is a full-page table giving problems/solutions, with difficulties common to Romanowsky-type stains. Problems that occur with the commonly used supra-vital stain new methylene blue are not addressed. The discussion of stains might be more complete with mention of adjunct stains such as Gram, periodic-acid Schiff reagent, and specific enzymatic stains.

The step-by-step illustrations of slide preparation are excellent. Algorithms are well laid out and informative and appear throughout the book. Tables contain good, concise information. The schematic drawings of cells and procedures are extremely helpful.

The greatest problem in the area of photomicrographs in the text is weak visual presentation and editing. Some of the photomicrographs have been poorly photographed or poorly reproduced, and cellular detail is lacking. The stain used and magnification of the photographs are inconsistently listed. The text and photomicrographs sometimes are "out of sync," with photomicrographs preceding text description by as much as 4 pages. When the reader is referred to a plate, the specific figure is not given. The use of arrows and other labels to specifically identify described morphology is grossly underused, which is disappointing, because the overall quality of the book suggests that the authors intended its usefulness for students and experienced practitioners.

Because the authors favor a systems approach, the table of contents reveals an organizational weakness. Topics one might expect to be discussed in close proximity are separated by discussions of other organ systems. For example, Chapter 8 covers the lymph nodes and Chapter 17 discusses the splenic parenchyma. Cross-referencing to other chapters avoids repetition, but not always successfully.

The index is inconsistent. For example, although mycotic agents are listed only under the general heading of "Infectious agents," parasites are listed individually, under "Infectious agents" where appropriate and under the heading of "Parasitism" also. Terms somewhat specific to cytology, like lymphoglandular bodies, are not indexed, although they are discussed and photographed on page 95.

This high-caliber cytologic text is reasonably priced and belongs in any veterinary library, especially a working library. Although there are some organizational flaws, they are quickly overridden by the comprehensive coverage of cytologic samples encountered in veterinary medicine.—*[Diagnostic Cytology of the Dog and Cat. Edited by Rick L. Cowell and Ronald D. Tyler. 259 pages; illustrated. American Veterinary Publications Inc, 5782 Thornwood Dr, Goleta, CA 93117. 1989. Price $75.45.]*—Laurie G. O'Rourke

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About the cover

Shepherdess with her Flock and Dog was drawn by Jean-François Millet (French, 1814-1875) in a style not unlike other French realists of the Barbizon school. Artists in this group were the first landscapists to work in the open air, which allowed them to replace the traditional view of nature with one more authentic. Millet became known as the first French artist to treat the worker and his milieu as a serious subject. Having been born into a peasant family, Millet did not idealize rustic life, but he did want to portray peasants, their labors, and their countryside as they really were.

Crayon and pastel were the media used for this 14-¼ × 19-¼-inch drawing. The Museum of Fine Arts, Boston granted permission to reproduce this drawing, which was a bequest (1935) of Mrs. Henry Lee Higginson in memory of her sister, Pauline Agassi-Shaw.

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Special Report

A survey of equine parasite control practices in Tennessee

Craig R. Reinemeyer, DVM, PhD, and Barton W. Rohrbach, VMD, MPH

Summary: *A weighted, random sample of 130 horse owners in Tennessee was selected from subscribers to an equine newsletter published by the Agricultural Extension Service. Data about the participants' farms, horses, parasite control practices, and sources of information regarding equine parasite control were obtained through a telephone survey. The response rate was 98%.*

The typical respondent kept 4 horses on 2 pastures totaling 15 acres, and did not rotate pastures as a parasite control measure. The majority (83%) of horse owners indicated that they administered anthelmintics according to a regular schedule; 9% delayed deworming until the onset of weight loss.

Proportions of owners deworming the various classes of horses at least 1, 2, 3, or 4 times annually were as follows: foals (0 to 6 months) 100, 60, 15, and 0%, respectively; weanlings (6 to 12 months) 100, 91, 32, and 0%, respectively; yearlings (1 to 2 years) 100, 100, 86, and 51%, respectively; and adults (> 2 years) 100, 94, 56, and 24%, respectively. Median treatments of yearlings and adults were evenly spaced at 6-, 4-, or 3-month intervals when the owners dewormed 2, 3, or 4 times annually, respectively. Mean intervals between treatments of foals and weanlings were less regular.

Of the horse owners who dewormed 2 or more times annually, most (53 to 80%) used the same product exclusively for all treatments. In all age classes of horses, ivermectin paste (46 to 63%) was the most common product used, followed by tube deworming (23 to 38%) and use of benzimidazoles (4 to 16%). Nearly all respondents (98%) planned to use the same anthelmintics the next year, and 91% intended to maintain the same frequency of treatment.

Equine-oriented magazines (41%) and veterinarians (27%) were considered the most important sources of information about when to deworm horses, and veterinarians (75%) were the most important source of information about which product to use.

Internal parasite control is one of the most important and most frequently administered health care measures for horses. Horse owners consider it essential for prevention of colic, maintenance of body weight and condition, and achievement of optimal growth and performance.[1]

The most crucial elements in the success of an equine parasite control program are selection of appropriate anthelmintics and proper timing of administration.[2] Despite the importance of these factors, little detailed information about parasite control practices of horse owners is available. Accurate data, including identification of the anthelmintic products used and the timing and frequency of their administration, are essential for critical evaluation of the relative merits and deficiencies of a parasite control program.

Not all equine parasite control measures are ultimately beneficial; some may be ineffective, and others may be potentially harmful. Surveys of parasite control practices for cattle in Britain indicated that nearly half of all treatments were wasted.[3] Reasons for ineffective usage included treatment of the wrong classes of cattle, use of incorrect drugs for the target parasites, and treatment at the wrong time of year. Anthelmintic wastage may be greater for horses than for cattle, because horses are treated more frequently. In addition, many populations of cyathostomes (small strongyles) have become resistant to several chemically related dewormers, whereas anthelmintic resistance seldom has been documented in cattle.[4] Continued use of drugs to which a population of worms is resistant further intensifies genetic selection and reduces the heterogeneity of the population.

Parasite control constitutes a considerable expenditure for horsemen. According to a 1981 survey, Quarter Horse owners in the United States spent an average of $27/horse/yr for internal parasite control.[5] On the basis of this figure and an approximate US horse population of 6.6 million,[6] a conservative estimate of the total expenditure for equine anthelmintics during 1987 was $178 million.

The objective of the survey reported here was to determine the parasite control practices of a

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The authors thank Dr. Hugh S. McCampbell and Ms. Carol Swearingen for assistance with the survey.

representative sample of horse owners in Tennessee.

Materials and methods

Selection of the study sample—The survey sample was selected from subscribers to an equine newsletter (*Tennessee Horse Express*, Agricultural Extension Service, The University of Tennessee Institute of Agriculture) that is published bimonthly. The newsletter is distributed free of charge to people in each county in Tennessee through the office of the county extension agent. The relative number of horse owners in each county in the state was estimated, using a 1982 census[7] of the equine population in Tennessee (Fig 1). The assumption was made that the number of horse owners in a county is highly correlated with the number of horses.

The sampling procedure was conducted in 2 stages. The first stage determined the number of people from each county to be included in the survey. Using a weighted, randomized method, each county was assigned a unique range of numbers depending on the relative size of the horse population within the county. This range represented the number of chances that a horse owner had to be included in the survey sample. The weighted method assured that horse owners residing in a county with many others had a probability of being included in the survey equal with that of owners residing in a county less populated by horse owners. This method selected the county of origin for the sample of 130 Tennessee horse owners.

In the second stage of sampling, a predetermined (in stage 1) number of people was selected randomly from the newsletter subscription lists of each county. If the candidate did not have a telephone, or did not own and/or was not responsible for the care of any horses, a replacement was selected randomly from the remaining subscribers in the same county.

Survey questionnaire—Information was solicited for the period Jan 1 to Dec 31, 1987. Participants were requested to provide information about their farms, and to describe the demographics of resident animal populations. Owners were asked how they decided when to deworm horses and which products were used. Information about internal parasite control programs was collected for the following equine subclasses: foals (0 to 6 months); weanlings (6 to 12 months); yearlings (1 to 2 years); adult horses (> 2 years), and broodmares. Participants were asked to rank the perceived efficacy of various routes of anthelmintic administration, to list any anthelmintics that had been discontinued, and to describe their plans for altering parasite control practices in the subsequent year. In addition, participants were requested to identify their major sources of information about control programs and anthelmintics, and to assess the adequacy of their information on equine parasite control.

Results

Of 130 people contacted, 128 (98%) were willing to participate in the survey. Of the original pool of candidates selected for the study, 12 of 130 (9%) did not have a current telephone listing, and 2 of 130 (2%) had not owned or cared for any horses during 1987. Replacements were selected for those 14 persons according to the procedure described previously. Only 2 of 130 (2%) contacts declined to participate in the study; one of these had a hearing disability and could not understand the interviewer.

Of 128 respondents, 111 (87%) kept horses at their place of residence. Median farm size was 50 acres, and the median number of acres used as horse pasture was 15. Two or more pastures were available for horses on 93 of 128 farms (73%), and 42 of 128 farms (33%) had 3 or more pastures. Of respondents with 2 or more pastures, only 24 of 93 (26%) used rotation of pastures as a specific technique to control parasitism.

Of the 128 respondents, 125 (98%) cared for

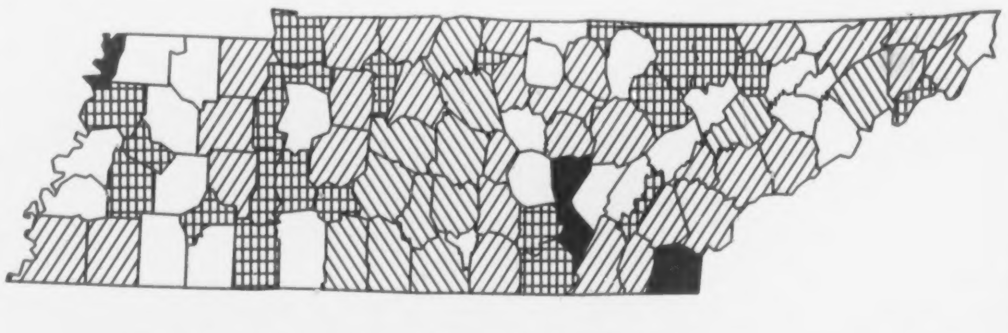

Figure 1—Distribution of the horse population in Tennessee by county, 1982.

a total of 707 adult horses, 53 (41%) cared for 215 pregnant mares, 40 (31%) cared for 139 foals, 29 (23%) cared for 100 yearlings, and 13 (10%) cared for 83 weanlings. The median number of horses cared for by survey participants was 4.

One hundred six respondents (83%) dewormed their horses according to a regular schedule; 12 (9%) regarded the onset of weight loss to be the most important factor for determining when to deworm.

All respondents (40/40) dewormed foals at least once before foals reached 6 months of age. A second deworming was administered by 24 of 40 foal owners (60%), and 6 of 40 (15%) dewormed the foals 3 times. The 16 of 40 owners (40%) who dewormed foals only once did so at a mean foal age of 4.9 months; 18 of 40 owners (45%) dewormed foals twice at mean foal ages of 2.3 and 5.3 months, and 6 of 40 (15%) dewormed foals 3 times at mean foal ages of 2.2, 4.0, and 5.7 months of age.

All respondents (22/22) dewormed weanlings at least once. A second treatment was administered by 20 of 22 owners (91%), and 7 of 22 (32%) dewormed weanlings 3 times. The 2 of 22 respondents (9%) who dewormed weanlings only once treated them at a mean weanling age of 8.5 months; 13 of 22 owners (59%) dewormed weanlings twice, at mean ages of 7.9 and 11.2 months, and 7 of 22 (32%) dewormed weanlings 3 times, at mean weanling ages of 7.6, 9.4, and 11.3 months.

Yearlings were dewormed at least twice by all respondents (35/35), and third and fourth treatments were administered by 30 of 35 (86%) and 18 of 35 (51%) owners, respectively. Of 35 owners, 5 (14%) dewormed yearlings twice, during the median months of March and September; 13 of 35 owners (37%) dewormed 3 times during the median months of March, July, and November, and 18 of 35 (51%) administered 4 treatments to yearlings during the median months of February, May, August, and November.

All respondents (126/126) dewormed mature horses at least once annually, and 119 of 126 (94%) dewormed horses twice. Third and fourth treatments were administered by 70 of 126 (56%) and 30 of 126 (24%) owners, respectively. Only 7 of 126 owners (6%) dewormed mature horses once annually, during the median month of June. Of 126 owners, 49 (39%) dewormed adult horses twice annually in the median months of March and September; 40 of 126 (32%) dewormed 3 times/yr in the median months of February, June, and October, and 30 of 126 (24%) dewormed adults 4 times/yr in the median months of February, May, August, and November.

All 53 owners who cared for broodmares dewormed them during the 3 months after foaling, and 51 (96%) administered anthelmintics during the 3 months prior to breeding. Pregnant mares were treated during the first and second trimesters by 38 (72%) and 46 (87%) owners, respectively, but only 18 of 53 owners (34%) dewormed during the third trimester.

Table 1—Proportion (%) of horse owners in Tennessee who treated various classes of horses two or more times annually and used the same anthelmintic or route of administration exclusively

Class	No. of owners	Ivermectin	Intubation*	Benzimidazole
Foals	16/20 (80)	9/16 (56)	5/16 (31)	2/16 (12)
Weanlings	13/20 (65)	6/13 (46)	5/13 (38)	4/13 (16)
Yearlings	26/35 (74)	15/26 (58)	10/26 (38)	1/26 (4)
Adults	71/119 (60)	45/71 (63)	16/71 (23)	10/71 (14)
Pregnant	27/51 (53)	15/27 (56)	9/27 (33)	3/27 (11)

*Individual products were not specified.

Depending on the class of horses treated, 53 to 80% of the horse owners in Tennessee who dewormed 2 or more times during 1987 used a single product exclusively (Table 1). Ivermectin (46 to 63%) was the most common product used exclusively, followed by products administered by stomach tube (23 to 38%), and benzimidazoles (4 to 16%). An attempt was not made to identify the various drugs administered by use of nasogastric intubation; this information may not have been conveyed to the owners by the attending veterinarians.

Nearly all respondents (125/128; 98%) indicated that they planned to use the same drugs the next year. Only 12 of 128 (9%) respondents indicated that they intended to deworm horses more often in the subsequent year; 116 of 128 (91%) planned to maintain the same frequency of treatment.

Only 18 of 128 respondents (14%) had discontinued the use of any equine anthelmintic. Reasons for discontinuing use ranged from adverse side effects to economic considerations, but no owners cited reasons associated with anthelmintic resistance.

Similar proportions of respondents considered nasogastric intubation (54%) and oral administration of pastes (44%) to be the most effective means of deworming horses. Orally administered liquids were considered best by 2 of 128 respondents (2%); none considered all routes of administration to be equally effective, and 1 had no opinion.

The relative importance of various sources of information about equine parasite control programs and anthelmintics is seen in Table 2. Equine-oriented magazines and veterinarians were the most important sources of information about parasite control programs and anthelmintics, respectively. Seventy-eight respondents (61%) believed they had sufficient information to enable them to prevent or control worms effectively. A similar proportion, 81 of 128 (63%), perceived a need to learn more about equine parasite control.

Discussion

Our sampling method was designed to provide equal representation by county, based on estimated numbers of horse owners. Selecting partic-

Table 2—Most important sources of information about parasite control and choice of anthelmintic: frequency of responses by Tennessee horse owners, 1987

	Control programs	Anthelmintic
Information source	No. of respondents (%)	No. of respondents (%)
Veterinarians	34 (27%)	98 (75%)
Equine-oriented magazines	53 (41%)	11 (9%)
Other	18 (14%)	9 (7%)
Word of mouth	9 (7%)	5 (4%)
Feed store personnel	7 (6%)	6 (5%)
Package inserts	7 (6%)	1 (1%)
County extension agents	0	0
4-H advisors	0	0
Meetings; programs	0	0

ipants from subscribers to an educational newsletter, however, could bias the sample toward horse owners who were more knowledgeable or more concerned about the health of their horses. Also, by eliminating subscribers that had no current telephone listing, our sample may have been biased toward people with higher incomes and, therefore, the financial means to provide better health care, including more rigorous parasite control practices. If these assumptions are correct, the responses obtained in this survey may represent a standard of equine health care that is better than average. Owing to the random method of selection of our survey population and the high response rate (98%), the results of this survey may have implications for horse owners outside the state of Tennessee.

The majority (83%) of respondents used a regular schedule to determine the timing of anthelmintic treatments. Median treatments of yearlings and adults were evenly spaced at 6-, 4-, or 3-month intervals when the owners dewormed 2, 3, or 4 times annually, respectively. Mean intervals between treatments of foals and weanlings were less regular.

Despite the administration of anthelmintics according to a regular schedule, only 6 of 40 (15%) and 7 of 22 (32%) owners of foals and weanlings, respectively, dewormed at intervals appropriate to prevent patent infections with *Parascaris equorum*, a major nematode pathogen of young horses.[8] Because the minimal prepatent period for *P equorum* is approximately 11 weeks,[9] ascarid prophylaxis requires that treatments begin at 2 months of age and be repeated bimonthly through the first year of life.[10] Longer treatment intervals could permit environmental contamination with ascarid eggs, which can remain viable for several years.[11] Treatment intervals for yearlings and adults were uniformly longer than 11 weeks, but ascarid infections in horses > 1 year old are controlled by host immunity and have little pathogenic or epidemiologic impact.[12]

Only 15% of foals, 32% of weanlings, and no adults or yearlings were dewormed frequently enough to prevent patent cyathostome (small strongyle) infections. The egg reappearance period for cyathostomes is approximately 4 weeks after treatment with most equine anthelmintics, and approximately 8 weeks after treatment with ivermectin.[13] The shortest median interval between treatments of adults and yearlings in this survey was 3 months. Depending on the choice of drugs, these programs permitted cyathostomes at least 4 to 8 weeks of patency after treatment.

The typical schedule of deworming reported in this survey probably achieved intermittent removal of adult worms, but did not accomplish the primary objective of parasite control programs, that is, prevention of environmental contamination with eggs.[10, 14] This deficiency, however, does not necessarily support the inference that these programs were practical failures; indeed, only 9% of respondents reported clinical evidence of parasitic disease (weight loss). Most owners perceived their parasite control programs to be effective, as indicated by the observation that 91% intended to use the same products at the same frequency during the subsequent year. Owners did not plan to decrease the frequency of treatment despite recent recommendations for strategic control programs that are based on fewer treatments given at ecologically critical times in the parasitic cycle[15] or on minimal treatments combined with pasture hygiene.[16]

The majority (72 to 100%) of owners dewormed broodmares during the 3 months before breeding and after foaling, and during the first 2 trimesters of pregnancy, but a lower proportion (34%) dewormed during the last trimester. This exception may reflect adherence to recommendations associated with carbon disulfide and organophosphate dewormers, which were used more commonly in the past than today. Use of these products is contraindicated in the last month of gestation,[11, 17] but other currently marketed equine anthelmintics do not have similar precautions during that period. Horse owners do not need to withhold anthelmintic treatments on the basis of advanced pregnancy.

High proportions of owners (53 to 80%) that gave 2 or more treatments tended to use the same anthelmintic exclusively (Table 1). The trend of exclusive anthelmintic usage is disturbing because frequent and repeated use of the same or chemically related drugs exerts strong selection pressure for the development of resistance by target organisms. Although treatment intervals reported in this survey were too long to prevent contamination, they were, nevertheless, sufficiently short to select for resistance. Surveys in Australia[18] have indicated that benzimidazole resistance developed in horse herds treated at intervals of 16 weeks or less, a treatment frequency reported in this survey by 56 and 88% of owners of adult and yearling horses, respectively. The problem of exclusive drug usage becomes even more alarming when one considers that 98% of respondents planned to use the same anthelmintics in the subsequent year.

Ivermectin was the most common drug used exclusively by respondents to the survey. Although resistance to ivermectin has not been documented for equine nematodes, practices such as exclusive usage and frequent treatment could foster its development. Naturally acquired ivermectin resistance has been reported in sheep,[19, 20] and resistance has been induced experimentally in lambs.[21] In addition, decreased degradation of feces has been reported in pastures grazed by horses treated with ivermectin,[a] and exclusive use of ivermectin could intensify any deleterious ecologic effects.

It is unfortunate that a large proportion (54%) of horse owners continues to attribute superior efficacy to "tube worming" despite a lack of supporting evidence.[b] This traditional notion persists even though most drugs administered by nasogastric intubation are available in alternate forms that can be given orally or added to feed. Tube worming is not without some hazard to the horse, handler, and veterinarian; it is regrettable that consumer preference and tradition foster the perpetuation of this atavistic and scientifically indefensible practice.

At 41%, horse-oriented publications were a more important source of information about parasite control programs than were veterinarians (27%). Equine-oriented magazines have a responsibility to publish accurate and up-to-date information about parasite control, and recognized authorities should be encouraged to exploit this venue for dissemination of current information

Veterinarians (75%) were the most important source of information about the choice of anthelmintics. Ideally, this vote of confidence by consumers can serve as a foundation for the increased involvement of veterinarians in designing, implementing, and monitoring equine parasite control programs.

Several potential deficiencies in parasite control practices were revealed by this survey. The following recommendations are offered. Anthelmintic treatments for foals should begin at 2 months of age and should be repeated bimonthly until weanlings are 12 months of age, to prevent patent infections with *P equorum*. To minimize transmission of cyathostomes, intervals between treatments should not exceed the minimal egg reappearance period (4 weeks, with use of standard anthelmintics; 8 weeks, with ivermectin) during periods when environmental conditions are favorable for development of eggs to larvae. Practices that result in strong selection for development of anthelmintic resistance (eg, frequent and repeated use of drugs of the same chemical class) should be avoided, alternatives for treatment at regular intervals should include strategic seasonal treatments[13, 15] and pasture hygiene,[16] and veterinarians should inform horse owners about factors that select for anthelmintic resistance. Administration of anthelmintics by nasogastric intubation should be discouraged. Horse owners need to become better informed about parasite control practices and anthelmintics, equine-oriented magazines should attempt to publish current, expert information on those subjects, and practitioners need to assume a greater role in recommending and monitoring control programs.

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Food Animal Economics

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Cat aggression redirected to people

Brucella abortus infection in 14 farm dogs

Behavioral problems in old dogs

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Prevalence of disease in nonviremic cats previously exposed to feline leukemia virus (C. L. Swenson et al)

Mycoplasmal mastitis in a dairy herd (M. B. Brown et al)

Methods for control of lamb epididymitis in large purebred flocks (M. [illegible] Bulgin et al)

Naltrexone for treatment of acral lick dermatitis in dogs (S. D. White)

Serratia marcescens mastitis in a dairy herd (D. J. Wilson et al)

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[illegible] infection in dairy cattle (D. A. Smith et al)

Serologic survey for Borrelia burgdorferi antibody in horses referred to a mid-Atlantic veterinary teaching hospital (W. V. Bernard et al)

Hypercalcemia secondary to cholecalciferol rodenticide toxicosis in two dogs (G. K. Fooshee and S. D. Forrester)

Polycystic kidney disease in a family of Persian cats (D. S. Biller et al)

[illegible] bilateral [illegible] syndrome [illegible] with [illegible] respiratory [illegible] ([illegible] et al)

Rate of enrollment decline eases

Statistical information provided by the Association of American Veterinary Medical Colleges indicates that the 1989-1990 enrollment of 1st-year students declined by only one student in the 27 US veterinary colleges. In the preceding year, first-year enrollment declined by 12, and two years ago, by 60. Enrollment in the four Canadian colleges increased by one. Total enrollment in DVM-degree programs in the United States and Canada declined by 104, compared with a decrease of 136 in 1988-1989. For the 1989-1990 academic year, 9,614 students were enrolled (Table 1), including 8,456 in the US colleges and 1,158 in the Canadian colleges. Canadian enrollment increased by 14 students over the preceding year.

Of the total US and Canadian enrollment in DVM-degree programs, female students continue to outnumber male students, 59% to 41% (Table 1), compared with 58% to 42% in the preceding year. Of the 2,402 graduates, 6% were minority (non-Caucasian), and of those 6%, 82 were female and 57 were male. Total enrollment in US and Canadian graduate-degree and certificate programs in 1989-1990 is 2,642 (Table 2), down by 96 participants over 1988-1989. The 1989-1990 total includes 1,630 with and 1,012 without DVM or VMD degrees.

Enrollment by class is presented in Table 3, and geographic distribution of first-year students in the US veterinary colleges is shown in Table 4.

Written by Carole S. Jordan, staff writer, AVMA Division of Scientific Activities.

TABLE 1—Total enrollment in veterinary medical degree programs

	Male		Female		Total
	No.	%	No.	%	No.
United States	3,461	41	4,995	59	8,456
Canada	452	39	706	61	1,158
Total	3,913	41	5,701	59	9,614

TABLE 2—Total enrollment in US and Canadian graduate-degree and certificate programs

Graduate	MS	PhD	Certificate of internship	Certificate of residency	Certificate of residency and MS	Certificate of residency and PhD	Total
DVM	399	647	119	203	193	69	1,630
Non-DVM	491	521	—	—	—	—	1,012
Total	890	1,168	119	203	193	69	2,642

TABLE 3—Total enrollment of veterinary medical degree students by class year

College	1st Year	2nd Year	3rd Year	4th Year	Total
Auburn University	90	85	89	87	351
California, University of	123	115	122	114	474
Colorado State University	125	128	123	124	500
Cornell University	81	79	81	77	318
Florida, University of	80	81	83	73	317
Georgia, University of	82	73	66	79	300
Illinois, University of	83	83	72	85	323
Iowa State University	80	70	91	102	343
Kansas State University	99	98	87	94	378
Louisiana State University	65	57	65	77	264
Michigan State University	91	103	91	96	381
Minnesota, University of	62	67	62	68	259
Mississippi State University	43	43	40	44	170
Missouri, University of	64	62	63	68	257
North Carolina State University	72	65	70	63	270
Ohio State University	129	130	125	122	506
Oklahoma State University	71	54	69	65	259
Oregon State University	38	33	34	35	140
Pennsylvania, University of	110	101	102	106	419
Purdue University	69	59	61	56	245
Tennessee, University of	54	55	61	-0-	170
Texas A&M University	127	118	110	123	478
Tufts University	73	71	61	63	268
Tuskegee University	59	55	56	40	210
Virginia Polytechnic Institute	80	76	79	77	312
Washington State University	61	58	60	62	241
Wisconsin, University of	83	79	74	67	303
Total-US Colleges	2,194	2,098	2,097	2,067	8,456
Guelph, University of	102	101	99	98	400
Montreal, University of	74	71	73	72	290
Saskatchewan, University of	72	69	70	72	283
Atlantic Veterinary College	47	44	47	47	185
Total-Canadian colleges	295	285	289	289	1,158
Total-US and Canadian colleges	2,489	2,383	2,386	2,356	9,614

Table 4—Geographic distribution of entering class of veterinary students in US colleges

Residence	Universities																											
	Auburn	California	Colorado	Cornell	Florida	Georgia	Illinois	Iowa	Kansas	Louisiana	Michigan	Minnesota	Mississippi	Missouri	North Carolina	Ohio	Oklahoma	Oregon	Pennsylvania	Purdue	Tennessee	Texas A&M	Tufts	Tuskegee	Virginia Polytechnic	Washington	Wisconsin	Total
Alabama	48	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	...	...	...	57
Alaska	...	...	4	1	...	...	...	...	1	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	...	10
Arizona	...	1	14	...	...	...	...	...	1	...	...	...	...	...	1	1	...	1	...	1	...	...	...	...	...	2	...	22
Arkansas	...	...	...	...	...	...	...	...	...	15	...	...	1	1	...	...	3	...	...	...	...	...	...	...	...	...	...	20
California	3	118	...	...	2	1	...	2	9	1	1	4	4	...	...	1	2	1	3	4	1	...	1	2	...	3	8	171
Colorado	...	...	60	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	61
Connecticut	2	...	...	2	...	...	1	...	...	...	1	...	...	...	...	1	...	...	3	2	...	...	10	...	...	...	1	23
Delaware	...	...	...	1	...	...	...	...	...	...	...	2	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	5
District of Columbia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0
Florida	2	...	1	1	73	1	...	...	...	...	1	...	2	...	2	1	...	...	...	2	3	...	2	2	...	...	...	93
Georgia	1	...	...	...	...	60	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	3	...	...	...	66
Hawaii	...	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	6
Idaho	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11	...	11
Illinois	...	...	...	...	...	...	73	...	...	...	2	3	1	...	...	1	...	...	...	2	2	...	...	4	...	...	...	88
Indiana	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	36	...	...	...	...	...	...	...	37
Iowa	...	...	...	...	...	...	...	65	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	65
Kansas	...	...	...	...	...	...	...	...	57	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	57
Kentucky	31	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	2	...	...	...	36
Louisiana	...	...	...	...	...	...	...	...	1	46	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	48
Maine	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	4	...	...	...	...	6
Maryland	...	1	...	2	...	...	...	...	...	...	...	...	1	...	...	5	...	...	4	1	1	...	...	1	30	...	...	46
Massachusetts	...	...	...	...	1	...	...	...	...	...	1	2	...	...	...	2	...	...	...	...	3	...	48	...	...	...	1	58
Michigan	...	...	...	...	...	...	...	1	...	...	77	1	...	...	...	1	...	...	1	1	...	...	1	...	...	...	...	83
Minnesota	...	...	...	...	...	...	...	...	1	...	...	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35
Mississippi	...	...	...	1	...	...	...	...	...	...	...	...	23	...	...	...	...	...	...	...	...	...	...	2	...	...	...	26
Missouri	...	...	...	...	...	...	2	...	...	...	...	...	...	53	...	...	...	...	...	2	...	...	...	...	...	...	...	57
Montana	...	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	...	11
Nebraska	...	...	...	...	...	...	...	1	19	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	21
Nevada	...	...	2	...	...	...	...	...	...	...	...	...	...	7	...	2	...	1	...	...	...	...	...	...	...	...	3	15
New Hampshire	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	1	...	...	...	...	4
New Jersey	...	...	...	6	1	...	2	...	1	...	1	1	1	...	2	4	...	...	16	4	...	...	1	5	...	...	...	45
New Mexico	...	1	17	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19
New York	...	...	...	60	2	...	2	1	...	...	3	3	5	...	...	3	1	...	8	7	5	...	1	4	...	...	...	105
North Carolina	...	...	...	...	...	...	...	...	...	...	...	...	1	...	62	...	...	...	...	...	...	...	...	3	...	...	...	66
North Dakota	...	...	1	...	...	...	...	7	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
Ohio	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	95	...	...	...	...	...	...	...	1	...	...	...	96
Oklahoma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	63	...	...	...	...	...	...	...	...	...	...	63
Oregon	...	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	30	...	...	...	...	...	...	...	...	...	32
Pennsylvania	...	...	...	2	...	...	1	1	1	...	1	1	1	1	...	3	...	...	72	4	3	...	...	2	...	...	1	94
Puerto Rico	...	...	...	1	...	2	...	1	1	2	...	...	...	1	...	1	...	...	...	1	...	...	...	4	...	...	...	14
Rhode Island	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	3
South Carolina	...	...	...	...	...	15	...	...	...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	3	...	...	...	21
South Dakota	...	...	...	...	...	...	...	...	2	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
Tennessee	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	32	...	...	2	...	...	...	35
Texas	1	...	...	...	...	...	...	1	...	1	...	...	2	...	...	...	1	...	...	...	...	127	...	2	...	...	...	135
Utah	...	...	7	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	10
Vermont	...	...	...	2	...	...	1	...	...	...	...	...	...	...	...	...	1	...	1	...	1	...	...	...	...	...	...	6
Virginia	1	...	...	...	1	...	...	...	...	...	...	1	...	...	3	...	...	...	...	...	...	...	...	3	50	...	...	59
Washington	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	38	...	41
West Virginia	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	2	...	...	...	9
Wisconsin	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	67	71
Wyoming	...	...	8	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
Bahamas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Canada	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	1	5
England	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
Holland	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Malaysia	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Israel	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
Jamaica	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
Total	90	123	125	81	80	82	83	80	98	65	91	62	43	64	72	129	71	38	110	69	54	127	73	59	80	61	83	2,194

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About the cover

The Greyhounds of the Comte de Choiseul was painted by Gustave Courbet (1819–1877) in 1866. As a young man, Courbet traveled to Paris to study painting; however, there he shunned formal training to teach himself the rudiments of painting by studying the works of Spanish, Flemish, and French masters. Courbet always regarded himself as a pupil of nature, and eventually was known as a leader of The Realist School. His artistic aims were to reflect the manners, the ideas, and the appearance of his period. Once Courbet had made a name for himself, primarily through his portraits and forest scenes, he turned to promote democratic and social sciences. He was imprisoned for 6 months for his alleged destruction of the Column in Place Vendôme. He later fled to Switzerland, where he died.

Permission to reproduce *Greyhounds of the Comte de Choiseul*, a 35in × 46in oil-on-canvas, was granted by The Saint Louis Art Museum (Gift of Mrs. Mark Steinberg) where the painting is on display.

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Serodiagnosis of equine monocytic ehrlichiosis in selected groups of horses in Minnesota (T. W. J. Olchowy et al)

Special Report

National Animal Poison Information Network (NAPINet): Veterinary medicine's new dimension in human-animal service

W. B. Buck, DVM, MS; L.-M. Côté, MS, PhD; H. L. Trammel, PharmD

Early intervention in cases of animal exposure to chemicals and toxins not only saves animal lives and prevents residues in human food supplies, but also helps to reduce emotional distress and financial loss incurred by animal owners. Providing a network for telephone assistance and rapid response field investigations to facilitate successful early intervention brings another dimension to clinical and diagnostic veterinary toxicology. This new dimension also involves computer-assisted compilation of telephone-oriented assessments of history and clinical findings, enabling recognition of emerging and continuing toxic hazards in the environment.

Since the 1950s, telephone assistance has been a mainstay in the management of potential poisonings. Parents and physicians turn to the local poison control center for consultation and recommendations. Likewise, animal owners often seek telephone assistance for toxicologic problems when the veterinary clinic they usually use is closed.[1] When presented with a poisoning problem, many veterinary practitioners and animal owners call their local human poison control center, unaware that animal poison information centers at the Universities of Illinois and Georgia provide nationwide coverage. Although the human poison control centers can provide certain basic information, the staff of these centers seldom has the expertise to adequately recommend specific management and treatment procedures for the various species of domestic and wild animals.

The expert consultation provided by the animal poison information centers for early intervention strengthens the relationship between veterinarians and animal owners in several ways: enables owners to intervene early and prevent additional losses; encourages owners to more carefully observe their animals, and in so doing, monitor for possible environmental contamination; and prepares livestock owners to act quickly when uncommon signs of disease appear in their herds to minimize losses or contamination of meat, milk, and eggs. Furthermore, positive interactions between veterinarians and animal owners enhance the bond between the owner and his/her animal(s). Owners learn to view their pets as life savers, because the monitoring of their behavior can warn of potentially harmful chemicals and toxins. This perspective gives owners power to prevent poisoning and to intervene early if poisoning occurs, provided they have access to expert assistance. Through the process of strengthening the human-animal bond, the veterinarian becomes directly involved in human welfare.

History of the National Animal Poison Information Network (NAPINet)

In 1978, the College of Veterinary Medicine at the University of Illinois, decided to implement a toxicology training program. Faculty members were receiving a number of requests from practicing veterinarians and animal owners for telephone consultation regarding poisoning and chemical contamination of livestock and pets. As the number of calls increased, veterinarians in postdoctoral training became involved on a rotating, around-the-clock basis. The Animal Toxicology Hotline was born. Soon, this service evolved into a complex structure, consisting of not only telephone consultation, but also field investigation capabilities and diagnostic laboratory support. Eventually, it unfolded into an animal poison information center providing all these services, along with a computerized case record data base, now known as the Illinois Animal Poison Information Center (IAPIC).

For 11 years, the IAPIC has strived to meet the needs of poisoned and chemically exposed animals through a philosophy of integrated service, education, and research. The IAPIC has provided animal toxicologic consultation, trained veterinarians, veterinary students, and graduate students in toxicology, and has conducted basic and applied research. Although the IAPIC was initially oriented toward users in the state of Illinois, the necessity of its services was soon recognized nationally, as well as in Canada and Europe. Altruistically, the IAPIC at-

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From the NAPINet Association, 2004 S Wright, Urbana, IL 61801 (Buck), the Illinois Animal Poison Information Center, College of Veterinary Medicine, University of Illinois, 2001 S Lincoln, Urbana, IL 61801 (Buck, Trammel), and Consul-Tox Inc, RR 2, Box 14, Tolono, IL 61880 (Côté).

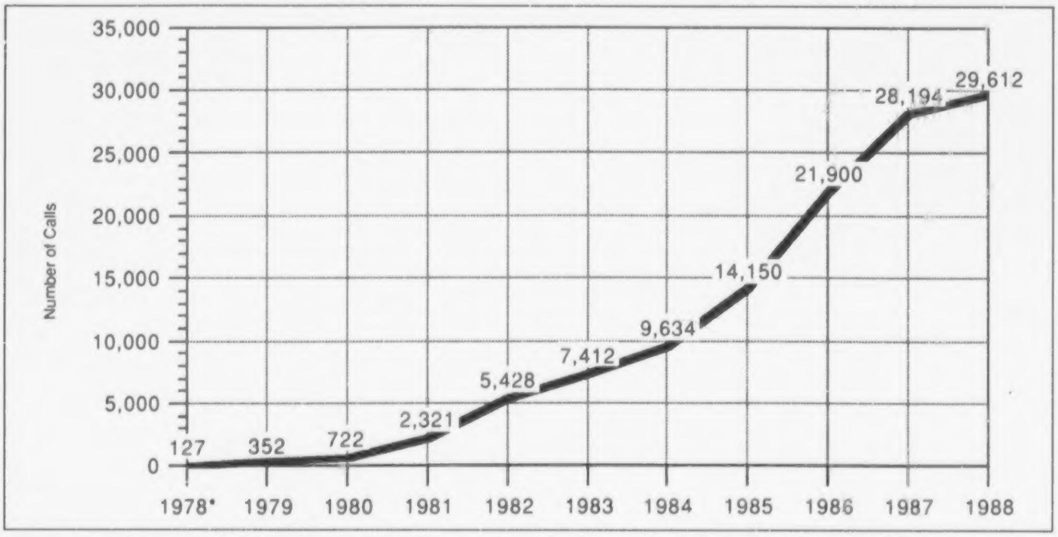

*Figure 1—Illinois Animal Poison Information Center call volume from 1978 (*3 months) through 1988.*

tempted to meet the national needs, but found itself continually pulled away from its original Illinois focus. By 1988, the center was handling nearly 30,000 calls annually (Fig 1), only 12% of which originated from Illinois.

Because the volume of calls surpassed the capacity of the service, resulting in constantly busy telephone lines, in 1987 the IAPIC began to work collaboratively with other strategically located veterinary toxicology groups to form a network of regional animal poison information centers. The existing resources in experienced veterinary toxicology groups could not only relieve the crowded IAPIC telephone lines, but could provide more efficient coverage of the United States and Canada, especially in conducting emergency investigations and handling local or regional problems. Thus, the NAPINet concept was developed.

Conceptually, the NAPINet is a network of autonomous regional animal poison information centers that has the NAPINet Association as its administrative and functional arm. To provide equal representation and power of decision, each regional center member is represented on the NAPINet governing board.

Reasons for networking include: operation with standardized protocols; involvement of existing animal toxicology groups within a unified structure; and provision of quality service, with more efficient use of financial and human resources. Although many toxicology groups in the United States and Canada provide information over the phone, the data are not computerized to be used as monitoring and learning tools. Unifying operational procedures assures the same quality and philosophy of services among centers. The resulting benefit of networking is the development of a substantial case record data base allowing scientists to study trends and problems associated with chemicals or natural contaminants.

Membership and finances

An early purpose of the NAPINet Association included the raising of funds to assist in the development and operation of regional centers. The Geraldine R. Dodge Foundation contributed $150,000 from 1987 to 1989, to facilitate the organization of the Association, publication of the *NAPINet Report*, and to assist in the development of new regional centers. During this 3-year period, only the Georgia regional center became operational; however, several other universities are investigating the feasibility of such a program. On the basis of experience at the Illinois center, an estimated $500,000 annually is required for a fully operational center. Unfortunately, the necessary funding for establishing the optimal 10 centers has not been forthcoming.

Membership in the NAPINet Association is open to practicing veterinarians, animal hospitals and clinics, animal owners, manufacturers, and others. Initially, the Association assumed the financial responsibility for a 24-hour, toll-free telephone number for the benefit of members only. Membership fees were used to meet the costs of telephone consultations, which necessitated annual fees ranging up to $250 for animal hospitals and clinics. Because of the exorbitant costs associated with routing the calls, this approach was abandoned in October 1989. Currently, the toll-free numbers are the responsibility of the Georgia Center (which charges telephone users on a subscription basis) and the Illinois Center (recently established a per-case charge). Therefore, membership in the NAPINet Association will not be linked with access to a regional center toll-free telephone number.

Benefits to members of the NAPINet Association now include provision of a membership certificate and a subscription to the *NAPINet Report* for an annual fee of $15. Sustaining manufacturer-members are also provided access to generic case data compiled on the central computer, which may assist in strategic development of safe products. Manufacturer-members are also given priority for field investigations of alleged problems involving their products in animals.

Objectives of the NAPINet

Facilitate the development of regional animal poison information centers and support their activities—The NAPINet regional centers are expected to provide services similar to that of the IAPIC: telephone consultation, diagnostic laboratory support, and field investigations. The contribution of toxicologists in the various regional centers will increase the effectiveness of all aspects of service, especially field investigations, because of their knowledge about the peculiarities of their region (eg, toxic plants, mineral status of soils, zootoxins, livestock production).

The NAPINet Association provides information about the needs and requirements for regional center status; assists in planning, organizing, and obtaining funds; and provides training and assistance in setting up operational procedures, especially as they relate to information handling and retrieval. In 1989, the NAPINet Association adopted criteria for regional center developmental phases.[a] Each NAPINet-certified regional center will have formal arrangements for analytical toxicologic support with a veterinary diagnostic laboratory that is certified by the American Association of Veterinary Laboratory Diagnosticians and ideally will be associated with such a veterinary diagnostic laboratory. The developmental phases include: preparatory, animal poison information center that plans to develop into a fully operational regional animal poison information center within 5 years; provisional, center that will develop into a fully operational center within 3 years; and regional (fully operational) center. An experienced veterinary poison information specialist will be in the preparatory center 8 hours/day, 365 days/year; in the provisional center, 16 hours/day; and in the fully operational center, around-the-clock. Regional centers in all developmental phases must be directed by a highly experienced clinical/diagnostic veterinary toxicologist. The regional center is expected to maintain adequate informational resources such as toxicology references, a computerized poison index,[b] and reprints of scientific papers.

Support by the NAPINet for the computerized operations entails standardization and consolidation of data collection, computer programming, storage of case data, and preparation of computer-generated reports. Data base programming, software, and other materials needed to facilitate the networking of the regional centers with a central computer are also part of the NAPINet efforts. A regional center should have computer capabilities compatible with other network centers to insure proper data transfer to the central computer.

Facilitate education and training at all levels of veterinary toxicology—Training clinical veterinary toxicologists will be a major function of NAPINet-certified regional centers. The Illinois center alone has awarded over 50 residency certificates and graduate degrees in toxicology. Each regional center will likely be located in a veterinary college that offers postgraduate degrees in toxicology. Structured on-the-job training has proven to be a fast and effective way to learn. Being able to assess the history and description of clinical signs of disease in exposed or poisoned live animals by telephone, then suggesting management and therapeutic measures to prevent or ameliorate the problem is a new dimension for clinical toxicology. Through these activities, a network of NAPINet regional centers will provide for training of clinical toxicologists to address this new dimension.

Improve the competence of veterinary practitioners, toxicologists, and other scientists—The NAPINet will also direct its educational focus on those who use the regional center services, informing them about potential hazards of chemicals and toxins not only to animals, but also regarding their public health and environmental aspects. Practicing veterinarians are faced daily with new problems ranging from poisoning of pets to chemical residues in livestock. Their need to obtain strategies to solve such problems is fulfilled by accessing the services offered by the NAPINet centers. In so doing, their need to know stimulates the continuing education process. Symposia for practitioners will be organized as a conventional continuing education vehicle for updating them on the basics of diagnosis and treatment. In addition, symposia and workshops will be organized to train regional center professionals, as well as other scientists who are interested in epidemiologic toxicology.

Provide professional communication via technical publications and scientific meetings—The *NAPINet Report*, the official publication of the association, provides information on occurrence, prevention, and management of poisoning and chemical exposure problems in animals. The subjects reflect cases encountered by the regional centers, viewed through the computerized epidemiologic window. In addition, the generic data collated by the NAPINet regional centers will be made available in the form of annual and periodic reports to private industry, governmental agencies, and other interested parties.

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[a] Copies of which are available from the NAPINet Association, 2004 S Wright St, Urbana, IL 61801; telephone (217)244-7732.

[b] POISINDEX, Micromedex Inc, 600 Grant St, Denver, CO 80203.

Encourage the advancement of technology and research in clinical veterinary toxicology and related areas—The NAPINet Association plans to provide assistance for quality assurance of the data generated by the regional centers, including development of standard formats and software for compiling case-data and implementing a system for scientific review and updating of toxicologic information.

Information relating to each case handled by the NAPINet regional centers will first be entered on the regional center computer and regularly sent to the NAPINet Association to be compiled on the central computer. The data base is a multi-table, relational model and permits searches for a wide range of information. Data include demographic information; animal information (species, breed, age, sex, and number exposed, affected, and dead); agent information (trade name, generic agents); exposure information (assurance, source, location, time, and route and amount of exposure); clinical signs of illness; and assessment of whether the problem was a toxicosis, suspected or doubtful toxicosis, or exposure without apparent effect.

The NAPINet regional centers will have opportunities to conduct research initiated from practical problems first encountered through their telephone service. For example, the IAPIC computer alone contains over 160,000 cases, probably the largest pool of data on spontaneous poisoning problems in animals. The resulting epidemiologic research by the NAPINet centers will involve the development of a scientific approach for predicting risks to human health and the environment from spontaneous animal exposure data. Studying incidents of spontaneous animal exposure is an acceptable alternative to animal experimentation. Useful and traditionally costly information may be gained without purposefully dosing animals. Moreover, comparison of data from human poison centers with that of NAPINet centers will enable recognition of situations in which animals do or do not serve as reliable predictors of human health hazards.

Not only can these data be used to identify potential problems in animals and human health, they also can be good indicators of product market trends. Such data are of value to manufacturers interested in the development of safe products. The continuous nature of regional center data collection provides a means for rapidly and sensitively detecting the emergence of new problem formulations into the marketplace or natural toxins in the environment.

In conclusion, a vast number of commercial products and natural contaminants pose potential hazards to livestock, pets, and exotic animals. When an emergency occurs, the rapidity and quality of the response for early intervention is critical. With the limited financial, physical, and human resources at our disposal, it has become obvious that a single center cannot adequately address the increasing demand for the services, either via telephone or field investigations. To minimize animal suffering and health and economic problems associated with chemical hazards, and to use the expertise available throughout the United States and Canada, the veterinary profession, animal industry, and pet-owning public must pursue the common goal of establishing a network of regional animal poison information centers.

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"Great-granddaddy, 1914," 1988

M. Lynne Kesel, DVM

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African horse sickness: A continuing menace *Corrie C. Brown and Ahmed H. Dardiri* 2019

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Cover artist

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Special Report

Coverage of sixty core veterinary medical journals by ten indexing and abstracting tools

R. J. Veenstra, MA, and J. C. Wright, DVM, PhD

Summary: *Ten indexing and abstracting reference sources were examined for their coverage of 60 core veterinary medical journals. The costs of the indexes also were compared. Coverage of the 60 core veterinary journals ranged from 8 of 60 journals by* Current Contents—Life Sciences *to 57 of 60 by* Index Veterinarius. *Based on yearly costs, format, and coverage of the 60 core veterinary journals,* Small Animal Practice *and the 2 editions of* Veterinary Reference Service *were determined to be the most useful for private practitioners. The* Index Veterinarius *gives the most complete coverage of the core veterinary journals for veterinary research workers who have access to a library.*

The literature of the veterinary medical field is vast and encompasses many specialized publications including journals, monographs, association proceedings, newsletters, and government publications. To provide efficient access to this complex literature, various indexing and abstracting reference tools have been developed. Although most of these reference tools are available in print, some have similar computer versions. A few reference tools or services such as the CONSULTANT database are exclusively available on-line. The indexing and abstracting tools to veterinary medicine vary considerably in accessibility and coverage; however, there is a lack of quantitative information about their important differences. The following reference tools were evaluated for their coverage of 60 core veterinary medical journals: *Bibliography of Agriculture, Biological Abstracts, Capsule Report, Current Contents—Agriculture, Current Contents—Life Sciences, Index Medicus, Index Veterinarius, Quarterly Index, Small Animal Practice*, and *Veterinary Reference Service* large animal and pet animal editions. (*See* Appendix for a brief description of each.)

Knowing more about the characteristics of specific indexes will improve the effectiveness and precision of information retrieval by veterinarians and veterinary researcher workers. Veterinarians have a large number of reference tools from which to select. These range from a few broad multidisciplinary tools such as *Bibliography of Agriculture* or *Biological Abstracts* that provide international coverage of thousands of animal-related publications, to more specialized and limited current awareness newsletters such as *Capsule Report* or *Small Animal Practice*.

The selection of specific printed indexing and abstracting reference tools to be included was based mainly on the list compiled by Boyd[1] of the Veterinary Serials Committee, Veterinary Medical Libraries Section, Medical Library Association. He recently published an updated version of the basic list of indexing and abstracting tools for veterinary medical literature. Most of the tools identified in the list were evaluated by us. However, to avoid duplication, only the most comprehensive tool, *Index Veterinarius*, was selected for a comparison of journal coverage. The only other omission from the list compiled by Boyd is the *Science Citation Index*. This important title was omitted because some of the data relating to the selection of the 60 core veterinary medical journals was derived from the citation data of the *Science Citation Index*. Also, the *Bibliography of Reproduction* was not included, because a list of journals cited was not available. Two newer reference tools gaining acceptance with veterinarians, *Small Animal Practice* and *Capsule Report*, also were included in the study.

All of the indexing and abstracting reference tools were evaluated for coverage of the core veterinary medical journals by examining a list of their journal coverage. Such lists of journal coverage typically are included as part of the indexing and abstracting tools, although some lists must be purchased independently, or may be obtained only on request. Only printed indexing and abstracting sources were compared for journal coverage. However, many of the printed tools also have similar on-line computer versions available, as described by Nielsen.[2] The coverage policies of reference

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From the Health Science Libraries, Hartford Hospital, Hartford, CT 06106 (Veenstra) and the Department of Pathobiology, College of Veterinary Medicine, Auburn University, AL 36849 (Wright).

Published as publication No. 2015, College of Veterinary Medicine, Auburn University.

Table 1—Coverage of 10 indexing and abstracting tools of the 60 core veterinary medical journals

	Bibliographic tool									
Journal	**BIB AG**	**BIO AB**	**CAPRP**	**CC AG**	**CC LS**	**I MED**	**I VET**	**QRT I**	**SAP**	**VRS**
Acta Veterinaria Scandinavica	−	+	−	+	−	+	−	−	+	+
Advances in Veterinary Science and Comparative Medicine	−	+	−	−	−	+	−	−	−	−
American Journal of Veterinary Research	−	+	−	+	−	+	+	+	+	−
Animal Genetics	−	+	−	+	−	+	+	−	−	−
Animal Production	+	+	−	+	−	−	+	−	−	+
Animal Reproduction Science	−	−	−	+	−	−	+	−	−	+
Australian Veterinary Journal	−	+	+	+	−	+	+	−	+	+
Australian Veterinary Practitioner	−	+	−	+	−	−	+	−	+	+
Avian Diseases	−	+	−	+	−	+	+	−	−	−
Avian Pathology	−	+	−	+	−	−	+	−	−	−
Bovine Practitioner	−	+	−	−	−	−	−	−	−	+
British Veterinary Journal	−	+	+	+	−	+	+	−	+	+
California Veterinarian	−	−	+	−	−	−	+	+	+	+
Canadian Journal of Veterinary Research	−	+	−	+	−	+	+	−	+	−
Canadian Veterinary Journal	−	+	+	+	−	−	+	+	+	+
Companion Animal Practice	+	+	+	+	−	−	+	+	+	−
Comparative Immunology Microbiology and Infectious Diseases	−	+	−	+	−	+	+	−	+	−
Compendium on Continuing Education for the Practicing Veterinarian	+	−	+	+	−	−	+	+	+	+
Cornell Veterinarian	−	+	−	+	−	+	+	+	+	+
Equine Practice	+	+	−	−	−	−	+	−	−	+
Equine Veterinary Journal	−	+	−	+	−	+	+	−	−	+
In Practice	−	+	+	−	−	−	+	−	+	−
Irish Veterinary Journal	−	−	−	+	−	−	+	−	+	−
Journal of Animal Science	+	+	−	+	−	+	+	−	−	+
Journal of Comparative Pathology	−	+	−	+	+	+	+	−	+	+
Journal of Dairy Science	−	+	−	+	−	+	+	−	−	+
Journal of Medical Primatology	−	+	−	+	+	−	+	−	−	−
Journal of Reproduction and Fertility	−	+	−	−	+	+	+	−	−	−
Journal of Small Animal Practice	+	+	−	+	−	−	+	+	+	+
Journal of the American Animal Hospital Association	−	+	+	+	−	−	+	+	+	+
Journal of the American Veterinary Medical Association	+	+	+	+	−	+	+	+	+	+
Journal of the South African Veterinary Association	−	−	−	+	−	+	+	−	+	+
Journal of Veterinary Internal Medicine	−	−	+	+	−	−	+	+	+	−
Journal of Veterinary Medicine, Series A: Animal Physiology, Pathology, and Clinical Veterinary Medicine	−	+	−	+	−	−	+	−	−	−
Journal of Veterinary Medicine, Series B: Infectious Diseases, Immunology, Food Hygiene, Veterinary Public Health	−	+	−	+	−	−	+	−	−	−
Journal of Veterinary Pharmacology and Therapeutics	+	+	−	+	−	+	+	−	+	+
Journal of Wildlife Diseases	+	+	−	+	−	+	+	−	−	−
Journal of Zoo Animal Medicine	−	+	−	+	−	−	+	−	−	−
Laboratory Animal Science	−	+	−	+	+	+	+	−	−	+
Laboratory Animals	+	+	−	+	+	+	+	−	−	−
New Zealand Veterinary Journal	−	−	−	+	−	−	+	−	+	+
Poultry Science	+	+	−	+	−	+	+	−	−	−
Preventive Veterinary Medicine	−	+	−	+	−	−	+	−	−	−
Research in Veterinary Science	−	−	+	+	−	+	+	−	+	+
Theriogenology	−	+	−	+	−	−	+	−	−	−
Tropical Animal Health and Production	−	+	−	+	−	+	+	−	−	−
Veterinary and Human Toxicology	−	+	−	+	−	+	+	−	+	+
Veterinary Clinics of North America: Equine Practice	+	−	−	+	−	+	+	−	−	−
Veterinary Clinics of North America: Food Animal Practice	+	−	−	+	−	+	+	−	−	−
Veterinary Clinics of North America: Small Animal Practice	+	+	−	+	−	+	+	−	−	−
Veterinary Immunology and Immunopathology	−	+	−	+	+	+	+	−	−	−
Veterinary Medicine	+	+	+	+	−	+	+	+	+	+
Veterinary Microbiology	−	+	−	+	+	+	+	−	−	+
Veterinary Parasitology	−	+	−	+	−	+	+	−	−	+
Veterinary Pathology	+	+	+	+	+	+	+	+	+	+
Veterinary Quarterly	−	+	−	+	−	+	+	−	+	+
Veterinary Radiology	−	+	−	+	−	−	+	+	−	+
Veterinary Record	+	+	−	+	−	+	+	−	+	+
Veterinary Research Communications	−	+	−	+	−	+	+	−	+	+
Veterinary Surgery	+	+	−	+	−	−	+	+	+	+

BIB AG = *Bibliography of Agriculture*; BIO AB = *Biological Abstracts*; CAPRP = *Capsule Report*; CC AG = *Current Contents—Agriculture*; CC LS = *Current Contents—Life Sciences*; I MED = *Index Medicus*; I VET = *Index Veterinarius*; QRT I = *Quarterly Index*; SAP = *Small Animal Practice*; VRS = *Veterinary Reference Service*

tools, however, are constantly adapting to the producers' perception of the needs of users. To allow for such changes, recent issues of reference tools also were examined to verify current journal coverage. It has become common practice for producers of reference tools to include sporadically selective coverage of other periodicals. Lists of periodicals with sporadic coverage generally are not available. Therefore, sporadic journal coverage of an index or abstract was excluded for consideration.

The selection of the 60 core veterinary medical journals was based on results of several studies: titles listed in Boyd's basic list of veterinary medical serials,[1] a 1986 journal citation report,[3] Garfield's citation study of 35 veterinary journals,[4] a survey of literature found in veterinary practices,[5] an analysis of journal citation frequency in the CONSULTANT database used for computer-assisted veterinary diagnosis,[6] and a journal-use study in a university veterinary medical library.[7] Each of these references identified important journals. English language journals that appeared repeatedly were identified and compiled into a list of 60 core journals representative of veterinary medical literature that could be used as a method to determine depth of indexing and abstracting reference tools. Table 1 is an alphabetic listing of 60 core veterinary journals and the indexing and abstracting sources that regularly cover the articles in each journal.

Previous comparisons of various indexing and abstracting tools have identified numerous types of criteria in addition to those reported here. Singh[8] proposed evaluations based on the numbers and type of indexing points, amount and completeness of bibliographic information, and types and number of publications covered. He also examined the depth of indexing and the types of abstracting. Lancaster[9] compared various indexes based on the amount of effort a user must spend to find a specified number of relevant citations. Lancaster also identified novelty as another important aspect of indexes. He defined novelty as the ability of the indexing or abstracting tool to provide an awareness of new information for a user, not simply to provide access to information with which a user is already familiar. Drage[10] emphasized the importance of user preference to indexing and abstracting services. He indicated that the general appearance of an index has a consequent physical impact on the individual user and concluded that this impact has a major role in the ease of use of a specific tool and the level of precision for information retrieved. Marsh[11] recently studied publication delay, or the lag time between an article in the area of "bioethics" being published and its citation appearing in the indexes. He concluded that delays are related to several factors, including frequency of publication. Some articles in similar indexes appeared as much as a year apart.

The ability of an index to cover journals in the veterinary medical literature is of primary importance to practicing veterinarians. There are many other valid criteria that may be used to examine indexing tools. The ease of use, novelty of information obtained, and lag time of citations appearing may be areas for future study. However, unless the indexing or abstracting tool covers desirable journals, all other considerations are of minimal importance.

Coverage of the 60 core veterinary journals by the 10 indexing and abstracting tools is seen in Table 1. The highest coverage is provided by *Index Veterinarius* (57 of 60 journals), and the lowest coverage is provided by *Current Contents—Life Sciences* (8 of 60 journals). The indexing tool with the second highest coverage of the core veterinary journals is *Current Contents—Agriculture* (53 of 60); similar to *Index Veterinarius*, it does not provide abstracts. Yearly costs ranged from $3,285 for *Bibliogical Abstracts* to $36 for *Small Animal Practice* (Table 2). *Biological Abstracts*, at a cost of over $3,000, is found only in research libraries; BIOSIS, an on-line version of this tool, may be accessed more economically through a vendor such as DIALOG.

There is considerable journal coverage overlap of the various tools (Table 1). However, journal coverage overlap may not necessarily mean journal article overlap, defined by Poyer[12] as "the same journal article being indexed by 2 or more services." Journal coverage by an index or abstract tool is seldom absolute and is more a matter of degree. One tool may provide access to every article, but then not provide access to other areas (eg, letters to the editor, editorials, or abstracts of meetings). Another tool may cover only 1 or 2 articles that are of interest to the primary audience. *Index Veterinarius* and *Biological Abstracts* approach cover-to-cover indexing for thousands of animal-related journals, although they do provide less complete depth of indexing for some of the non-English publications or for entries of minimal relevance. *Small Animal Practice* indexes 30 of the core veterinary journals, but omits many of the ar-

Table 2—Costs and core veterinary journals covered by 10 indexing and abstracting tools

Bibliographic tool	**Yearly cost**	**Core veterinary journals covered**
Bibliography of Agriculture	$ 515	18
Biological Abstracts	3,285	49
Capsule Report	47.50	13
Current Contents—Agriculture	283	53
Current Contents—Life Sciences	283	8
Index Medicus	163	36
Index Veterinarius	500	57
Quarterly Index	65	14
Small Animal Practice	36	30
*Veterinary Reference Service**	98	34

*Cost for the *Veterinary Reference Service* is for each edition (equine/food animal and small animal). Core veterinary journals covered for *Veterinary Reference Service* are the journals covered by both editions.

ticles that might be useful to veterinarians. In contrast, *Quarterly Index* provides access to every article in every journal that it covers, although it covers only 14 of the core list. *Veterinary Reference Service* and both issues of *Current Contents* also provide complete coverage of articles.

Each publisher usually compiles a list of key terms for subject headings in the arrangement of their index. This allows them to better serve the needs of their primary audience. Seldom are these lists of controlled subject terms made available to the public; exceptions are *Biological Abstracts* and *Index Medicus*. This is unfortunate, because the availability of a thesaurus of subject headings makes an index easier to use and improves effectiveness.

A survey of British veterinarians[5] indicated that they had 1 or 2 journals and 11 to 30 books in their private libraries. Because private veterinary practitioners also have limited access to a veterinary library, indexing tools that also provide abstracts are the most useful. Of the 10 bibliographic tools reported here, 6 provide this type of service: *Bibliography of Agriculture, Biological Abstracts, Capsule Report, Quarterly Index, Small Animal Practice,* and *Veterinary Reference Service*. However, abstracts may have considerable variation. The typical author abstract is informative and provides a brief summary of the article, written in the style and length established by the journal. Abstracts found in *Biological Abstracts* are of this type. Abstracts provided by the *Veterinary Reference Service, Quarterly Index,* and *Capsule Report* are written by a specialist in the field and usually comprise between 200 and 500 words, and provide more details about the article. Often this type of abstract will enable busy veterinarians to defer reading the original paper.

Small Animal Practice and *Capsule Report* newsletters offer the most critical or evaluative abstracts. In addition to providing summaries of selected papers, specialists place a value judgement on the article. Specialists may analyze the methods or the data analysis, and also may offer alternative conclusions. *Small Animal Practice* gives its evaluation in the Comments section immediately following the abstract, whereas *Capsule Report* includes critical comments within the text of the abstract. Critical abstracts are especially helpful to recently graduated veterinarians, because articles are placed in a broader perspective.

Appendix

The 10 indexing and abstracting tools evaluated, plus 2 others not evaluated, are described.

Bibliography of Agriculture is a monthly index to the literature of agriculture and allied sciences based on indexing and cataloging records found in AGRICOLA (Agricultural On-Line Access), the computerized bibliographic data files distributed by the National Agricultural Library. This abstracting service covers citations to journal articles, pamphlets, books, new serials, government documents, special reports, and other materials. Items from about 43 languages are represented. Annual issues are available. Over 5,000 journal titles are covered; however, many of the entries are for the subject of botany. (Cost $515/yr. Oryx Press, 2214 N Central at Encanto, Phoenix, AZ 85004.)

Biological Abstracts attempts to report worldwide research in the life sciences. In addition to the subject and author access points, there is a unique generic index that gives access according to genus and species names. Generic access may be especially useful for veterinarians who treat exotic animals. The abstracts are arranged within 84 major concept headings. This is a "key word in context" index that is published semimonthly with semiannual cumulative issues. It is the principle abstracting journal for the subject of biology (over 9,000 titles), with considerable coverage of veterinary literature. Related on-line files are available as BIOSIS (Cost of printed service $3,285/yr. Biosciences Information Services, 2100 Arch St, Philadelphia, PA 19103-1399.)

Capsule Report is a 4-page, monthly abstracting newsletter for people interested in current topics and trends in the field of veterinary medicine. Edited by William L. Collins, DVM, with an annual index issue, this service selectively covers about 56 veterinary related periodicals, newsletters, regional publications, reports, and seminars. Descriptive abstracts with evaluative comments written by specialists vary in length from 50 to about 400 words. Especially relevant details are highlighted with bold print for ease of use. (Cost $47.50/yr. 26942 Preciados, Mission Viejo, CA 92691.)

Current Contents—Agriculture, Biology & Environmental Sciences is one of several in the weekly current awareness series. This tool publishes tables of contents from the newest issues of relevant journals. Users may scan through the titles, or use a key word index or author index to locate entries. The index covers about 1,200 periodicals. A modified version is available on-line as SCISEARCH. The publisher also provides a document delivery service for articles by mail and telefax, or one may use the Author and Address Directory for requesting reprints. This edition of the *Current Contents* has the most complete coverage of the animal sciences. (Cost $283/yr. Institute for Scientific Information, 3501 Market St, Philadelphia, PA 19104.)

Current Contents—Life Sciences is identical in format to the other parts of this service. The Life Sciences section has limited coverage of the animal science journals. However, it has been found that veterinary researchers also rely heavily on many of the nonveterinary basic medical journals that are covered in this current awareness tool. (Cost

$283/yr. Institute for Scientific Information, 3501 Market St, Philadelphia, PA 19104.)

Index Medicus began as a listing of the holdings of the Surgeon General's library in 1865. Published since 1879 under various forms, this index continues as a cornerstone in medical literature and is now produced by the National Library of Medicine. Issues are published monthly and there is an annual *Cumulated Index Medicus*. Over 2,750 international journals in about 42 languages are indexed completely or selectively. In addition to coverage of the health sciences, there are entries for articles related to biology, entomology, chemistry, veterinary medicine, and zoology. Access may be by medical subject headings and by author(s). An especially useful section is the *Bibliography of Medical Reviews*. Modified versions of *Index Medicus* with a large percentage of abstracts not found in the printed format are available on-line or in CD-ROM through various vendors. (Cost of printed source $163/yr. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

Index Veterinarius is perhaps the most widely known of the specialized veterinary indexes. Published in monthly issues, this tool provides comprehensive coverage of the world's veterinary literature by providing access to information in approximately 1,300 journals in 40 languages. Books, conference proceedings, theses, and dissertations also are covered. Coverage of the journals may be cover-to-cover or selective. Articles concerning cattle, horses, sheep, goats, pigs, poultry, cats, dogs, cage birds, wildlife, exotic animals, laboratory animals, and fish are frequently included. Annual cumulations are available. A related on-line version is commercially available. (Cost of printed index varies; approximately $500/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Quarterly Index: Information Access for the Small Animal Practitioner provides the small animal practitioner with access to the information in 18 veterinary journals. There are original abstracts written by veterinarians for many of the entries, and every article, case report, and letter is accessible in the periodicals covered. The format of the index is unique and is arranged by periodical title. Articles are presented or abstracted in the order in which they appear in the journal. Users may browse through the index as if they were browsing through the actual journal. Citations refer the reader to the exact pages for the full article. Author and subject indexing is included, and the index has a cumulated annual edition. Of special interest is a "highlights" sheet arranged by subject, which draws attention to high-appeal articles. A document delivery service also is offered, and an on-line version of this index is available. The on-line version is designed specifically for inexperienced searchers. Built into the system is a revolutionary program that assists users by automatically identifying and searching for possible synonyms, thus lowering the cost and improving the relevance of the information obtained. (Cost of printed index $65/yr. Veterinary Interface, 5679 Claribel Rd, Oakdale, CA 95361.)

Small Animal Abstracts, although not evaluated by us, deserves mention. This too, provides quarterly abstracts concerning dogs, cats, and smaller pets. Designed as a low cost alternative for the small animal practitioner, this source is compiled from relevant data in the much more extensive *Veterinary Bulletin*. Cumulative subject and author index are included, and approximately 1,500 abstracts are published yearly. (Cost of printed index varies; approximately $96/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Small Animal Practice had its first issue published in January 1988. The goal of this 6-page newsletter is to survey and evaluate current developments in small animal medicine and surgery for immediate use in clinical practice. This abstracting newsletter selectively covers about 80 periodicals (some international in scope), proceedings, and regional publications. The editor, Kyle G. Braund, DVM, emphasizes the coverage of new and old diseases, new surgical methods and treatments, and diagnostic techniques. A glossy 2-color publication with bold headings, the newsletter's subject groupings and overview list called "In This Issue" makes it easy to use. (Cost $36/yr. Williams and Wilkins, 428 E Preston St, Baltimore, MD 21202.)

Veterinary Bulletin, although not evaluated by us, also deserves mention. It provides abstracts for about 40% of entries found in its companion tool, the *Index Veterinarius*. The monthly issues of the bulletin include the abstracts, and author and subject indexes. Unlike the other tools described, there are about a dozen review articles on veterinary subjects included as part of this service. (Cost varies; approximately $377/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Veterinary Reference Service: Clinical Abstract Service—Small Animal Edition and *Large Animal Edition* provide lengthy abstract summaries of the articles in about 40 journals. Articles are arranged by animal type. The general section of the small animal edition often includes articles on cage birds. In addition to the monthly loose leaf sheets (about 32 pages), there is an annotated index provided for each monthly issue. The cumulative annotated index can be quickly and easily scanned for relevant articles. (Cost $98/yr each. American Veterinary Publications Inc, 5782 Thornwood Dr, Goleta, CA 93117-3896; 1-800-235-6947.)

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Food Animal Economics

Veterinary and nonveterinary costs of disease in 29 California dairies participating in the National Animal Health Monitoring System from 1988 to 1989

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Summary: *Twenty-nine California dairy herds were studied over a 12-month period from 1988 to 1989 as part of the National Animal Health Monitoring System. Monthly interviews administered to dairy producers were used to measure the costs of all health-related expenditures and disease incidence in these herds. Of the total $1,523,558 reported, $1,355,467 (89%) was attributed to cost of disease events and $168,091 (11%) to cost of disease prevention. Most (78%) of the cost of disease events was attributable to death and culling losses. Veterinary services accounted for only $54,099 (4%) of total costs, 64% of which was used for disease prevention, compared with 36% for disease treatment. Udder disease was the most costly category of diseases reported at an average of $49.85/head at risk annually, followed by reproductive problems at $38.05. Through the use of sampling strategies less biased than those used in other surveys, the National Animal Health Monitoring System is designed to provide statistically-valid estimates of disease incidence and costs across broad geographic areas, potentially benefiting all those interested in the economics of livestock diseases in the United States.*

The National Animal Health Monitoring System (NAHMS) is designed to measure the incidence and cost of health-related events in livestock and poultry species. The NAHMS is coordinated by the USDA Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS) and represents a new direction from the agency's traditionally regulatory role. The history, organization, and potential benefits of the NAHMS program have been reviewed.[1-3] Through commitment toward an accurate assessment of the number of animals under observation and careful record-keeping of disease events and costs, incidence rates and costs per head can be determined from NAHMS data. These measures are useful to producers, veterinary practitioners, and government agencies attempting to reduce the economic impact of livestock diseases.

As economic pressures continue to increase, livestock producers are beginning to demand documented return on their investment for veterinary services; some of these needs can be fulfilled by NAHMS.[2] The NAHMS may also prove to be a valuable format for evaluating the broad health impact of management changes, possibly leading to cost-optimized production strategies.[2] The NAHMS differs from most livestock economic research in that attempts are made to study only herds that have been recruited through statistically valid sampling schemes.[1] To the extent that this helps reduce bias, the results of NAHMS surveys can be extrapolated to provide reasonable estimates for defined geographic areas. With the experience of several statewide dairy cattle NAHMS surveys over the past few years, NAHMS is now evolving into a single national program.[4] California has participated in NAHMS since 1983, thus far completing 3 dairy cattle surveys. The purpose of the study reported here was to use the NAHMS program to determine all obvious disease-related expenditures and cost components associated with veterinary services in 29 California dairy herds over a 12-month period from 1988 to 1989. Comparisons have been made between the amount and type of veterinary utilization indicated during initial producer interviews and that subsequently measured in the same herds during the study.

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Materials and methods

Herds were selected for participation in this study by use of an updated list frame of 2,493 herds designed to include all dairies in California.[5] The list frame was based on results of periodic *Brucella* ring tests recorded with the California Department of Food and Agriculture Animal Health Branch and with USDA:APHIS:VS. For this study, a desired sample size of 30 herds was determined on the basis of results of earlier Califoria NAHMS dairy surveys and considerations of the limitations of field personnel resources.

Survey information was collected from participating dairy producers by federal and state veterinary medical officers (VMO) who used standarized questionnaires. From the initial interview, farm level data on cattle inventory and general herd management information were obtained. Thereafter, VMO inverviewed participating producers on a monthly basis and recorded information regarding cattle inventory dynamics, herd-wide milk production, and monthly economic inputs and losses related to all health-related problems and their prevention. Producer-maintained records and receipts facilitated the accurate recall of cost information from each herd.

The value of animal deaths, culls, stillbirths, or abortions was estimated by producers as the market value on the basis of breed, gender, and age of an animal, minus any cull value. Anticipated production losses (ie, decreased milk production or weight gain) as a consequence of disease were not estimated. Labor costs were based on the average hourly employee or self-valued wage for each producer. Disease incidence and cost data were compiled for each class of animals in study herds, using the following definitions: calves were aged from birth until weaned off liquid rations; young stock were aged from weaning until sale, first calving (heifers), or first breeding use (bulls); cows were all females that had calved one or more times; bulls were males that had been used for breeding at least once. Each disease event was followed for a 2-week recovery period after diagnosis and treatment, whereupon animals were considered to be at risk for the same disease again; thus, some animals may have been counted more than once for the same health problem.

Each reported health condition or prevention was coded at the most specific level possible, using a standardized hierarchical coding scheme developed for this survey. Each specific condition was then linked to one of 18 categories of clinically similar diseases (Table 1). Cases for which a precise diagnosis was uncertain or not stated were listed directly in the most appropriate disease category, using available information; for example, cases of cows not pregnant were listed in the category of reproductive problems. To reduce the probability of disease misclassification, all analyses were performed by use of the 18 categories. Incorrect specification of the general category of individual disease events was considered to be rare.

Table 1—List of 18 disease categories and primary corresponding diseases used for the National Animal Health Monitoring System (NAHMS) California Dairy Program (1988 to 1989)

Disease category	Specific diseases and conditions included
Diarrhea	All conditions that result in abnormally loose feces
Digestive problems	Displaced abomasum, enteritis, colic, hepatitis, bloat, traumatic reticuloperitonitis, gastric ulcers, strangulated intestine
Diseases of parturition	Abortion, stillbirth, brucellosis, vibriosis, dystocia, mummified fetus
Eye problems	Foxtails in eye, pink eye/keratoconjunctivitis, ocular discharge, eye trauma, ocular squamous cell carcinoma
Lameness	Arthritis, synovitis, leg weakness/abnormal gait, foot rot, limb injury, hip injury, fracture, foot abscess, foot injury, limb trauma, bursitis, laminitis
Multiple systems problems	Infection with *Clostridia* spp, congenital abnormalities, hyperthermia, hypothermia/frostbite, anthrax, thromboembolic meningoencephalitis, poisoning, septicemia, snakebite, bluetongue, bovine viral diarrhea, starvation, injury/trauma, predation
Nutritional deficiencies	Any vitamin, mineral, or trace element deficiency
Oral lesions	Actinobacillosis, actinomycosis, oral lesions
Parasitism (internal)	Parasitic enteritis, anaplasmosis, internal parasitism.
Postpartum diseases	Milk fever, retained placenta, obturator paralysis, postparturient toxemia, prolapsed uterus, metritis, downer cow syndrome
Reproductive problems	Infertility, cystic ovary, trichomoniasis, luteal cysts, freemartins
Respiratory diseases	Lung worm, pneumonia, tracheitis, infectious bovine rhinotracheitis, sinusitis, parainfluenza 3 infection, drowning, suffocation, pleurisy, shipping fever, bovine respiratory syncytial virus infection
Skin diseases	Ringworm, warts, lice, skin abscesses, dermatitis, mites, wounds, fleas, ticks, hypoderma
Toxicoses	Grain poisoning, salt poisoning, unspecified types of poisoning
Tumors	All neoplastic processes except ocular squamous cell carcinoma
Udder disease	Mastitis (any cause), udder edema, agalactia, teat injury, udder injury
Undiagnosed disease	All entities for which a more precise diagnosis is uncertain or unavailable
Urinary disease	Renal disease, cystitis, urethritis

For rate calculations, the average monthly number of cattle at risk for disease and preventive medical efforts was estimated for each class of animals from the monthly cattle inventories. Average monthly inventories for each class of cattle were calculated as the mean of beginning-of-month and end-of-month values recorded during producer interviews. Study-wide averages were then determined by dividing the sum of monthly estimates by the total herd-months of observation. Only lactating cows were placed at risk for the category of udder disease. For diseases of parturition and postpartum diseases, the number of cattle at risk was defined as the sum of all calving events (live, aborted, or stillborn) during the study period. Because inadequate information was available to differentiate the reproductive status of young stock, only adults (cows) were considered to be at risk for reproductive problems.

A microcomputer-based relational database software program[a] was used for data management. The Wilcoxon rank sum test[6] was used to compare groups at an α level of 0.05. An estimate of the statewide total milk production and its associated 95% confidence interval was calculated from the total of monthly values, as described.[7]

Results and Discussion

Fourteen dairy producers were selected and recruited by simple random sampling from the list frame. An additional 15 herds were recruited from neighbors of producers that had declined to participate, providing a total of 29 herds for the study (Fig 1). Interviews were conducted between April 1988 and May 1989. All but one of these 29 herds contributed data for an entire 12-month period, for a total of 342 herd-months of observation. During this time, 13,254 cases of disease were reported to have cost $1,355,467, of which 78% was attributable to death and culling losses. An additional $168,091 was spent for disease prevention, for a total of $1,523,558 for health-related expenses in all herds during the year. The average monthly herd size was 680 head, including approximately 297 lactating cows/herd-month of observation. The average milk production per lactating cow was 691 kg/mo, with milk valued at $10.80/cwt, on average.

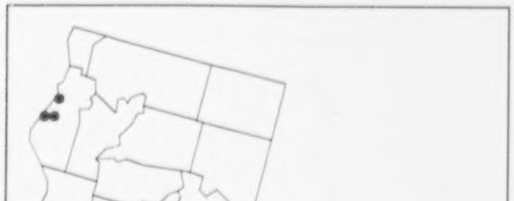

Figure 1—Geographic distribution of 29 California dairy herds participating in the 1988 to 1989 National Animal Health Monitoring System.

Schukken et al[8] evaluated the repeatability of dairy interviews and found an average of 13.4% errors/questionnaire when interviews were conducted a second time. The NAHMS interviews were repeated throughout the length of the study, to the extent that the expenses and outcomes of class-grouped inventories and disease events were continuously monitored. Inconsistencies in the data were addressed by VMO and producers on an individual basis as they were noticed. This scheme provided for a thorough error checking system, possibly increasing the validity of the final data set. The high month-to-month agreement between interview data in this study is partly documented by the observation that only 35 (0.26%) reported cases contained unexplainable discrepancies regarding their time of onset; that is, costs were accrued for ongoing health problems in 35 animals that were never involved in incident cases.

Statistically significant differences were not found between the randomly selected herds and substitute herds regarding total milk production, total cost of diseases and preventions, or total number of cases reported, suggesting that these 2 groups could be combined for the purposes of study summaries (Tables 2 and 3).

Private veterinary practitioners diagnosed 18.4% of reported cases; the majority of these cases were classified as diseases in the category of reproductive problems (58%), followed by postpartum diseases (25%) and digestive problems (5%). The VMO made the diagnosis for 4% of the cases, most of which (49%) were classified as respiratory disease. Diagnostic laboratories were used for only 42 cases (0.3%), 39 of which were used to identify a cause for udder disease. Veterinary services were responsible for $54,099 (3.55%) of the overall animal health-related costs in the study, indicating an average expenditure of $1,865/producer annually. This value is slightly higher than the $1,090 found in a national survey conducted by mail,[9] a result possibly attributable to the larger size of California dairies, the failure of dairymen to recognize all health-dollar inputs, or relatively greater spending by California dairy producers. Disease prevention was responsible for $34,834 of veterinary services charges, whereas the remaining $19,265 ($758 administered by nonveterinarians, such as contract hoof-trimmers) resulted from disease treatments. These values excluded costs of drugs administered by veterinarians, when it was possible to separate such costs from services. The majority (61%) of veterinary services in disease prevention resulted specifically from pregnancy diagnosis.

Although only 24 (83%) producers indicated during the initial interview that they regularly called veterinarians for individual case treatment, 27 (93%) producers actually reported such use

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[a] R BASE for DOS, Microrim Inc, Redmond, Wash.

Table 2—Summary of disease incidence and associated costs for the top 20 disease categories, ranked by overall cost, for 29 California dairy producers participating in the NAHMS (1988 to 1989)

Disease category*	Age group	No. head at risk	No.of cases	Incidence rate†	Cost of disease events ($)	Cost of disease preventions ($)	Combined cost of disease ($)	Annual cost per head at risk ($)
Udder disease	Cows	8,612	3,169	36.8	339,967	89,374	429,341	49.85
Reproductive problems	Cows	10,268	2,348	22.9	364,528	26,149	390,677	38.05
Diseases of parturition	Cows‡	9,979	945	9.5	113,077	15,271	128,348	12.86
Undiagnosed disease	Cows	10,268	289	2.8	127,249	0	127,249	12.39
Postpartum diseases	Cows	9,979	2,408	24.1	80,246	1,542	81,788	8.20
Lameness	Cows	10,268	528	5.1	72,012	6,924	78,936	7.69
Digestive problems	Cows	10,268	316	3.1	60,502	1,580	62,082	6.05
Diarrhea	Calves	1,617	1,229	76.0§	27,137	9,201	36,338	22.47
Respiratory diseases	Calves	1,617	956	59.1§	28,486	3,444	31,930	19.75
Multiple systems problems	Cows	10,268	71	0.7	23,241	1,190	24,431	2.38
Respiratory diseases	Young stock	7,770	233	3.0	17,428	1,038	18,466	2.38
Respiratory diseases	Cows	10,268	62	0.6	17,282	417	17,699	1.72
Reproductive problems	Young stock	10,268	22	0.2	10,343	979	11,322	1.10
Undiagnosed disease	Young stock	7,770	17	0.2	7,901	0	7,901	1.02
Diarrhea	Cows	10,268	37	0.4	6,975	685	7,660	0.75
Lameness	Young stock	7,770	32	0.4	7,400	5	7,405	0.95
Eye problems	Cows	10,268	88	0.9	6,845	0	6,845	0.67
Tumors	Cows	10,268	7	0.1	4,929	0	4,929	0.48
Multiple systems problems	Calves	1,617	50	3.1	4,256	202	4,458	2.76
Digestive problems	Young stock	7,770	10	0.1	3,735	314	4,049	0.52
All others combined	All groups	. . .	437	. . .	31,928	9,776	41,704	. . .
Totals	All groups	. . .	13254	. . .	1,355,467	168,091	1,523,558	. . .

**See* Table 1 for definitions. †Annual incidence proportion per 100 head at risk. ‡By definition, all first-calf heifers were classified as adults (cows). §High rates reflect repeated bouts per animal and dynamic nature of calf population.

*Table 3—Percent distribution of cost components for the top 20 disease categories, ranked by overall cost, for 29 California dairy producers participating in the NAHMS (1988 to 1989)**

Disease category†	Age group	Death losses	Culling losses	Carcass disposal	Milk loss‡	Treatments and preventives	Labor input	Veterinary services§
Udder disease	Cows	10	51	. . .	11	24	4	
Reproductive problems	Cows	. . .	90	. . .	. . .	2	1	7
Disease of parturition	Cows	64‖	20	1	. . .	6	4	5
Undiagnosed disease	Cows	59	37	. . .	1	1	1	1
Postpartum diseases	Cows	63	16	1	3	8	5	4
Lameness	Cows	6	74	. . .	5	6	3	6
Digestive problems	Cows	51	29	. . .	3	5	4	8
Diarrhea	Calves	48	. . .	2	. . .	36	14	. . .
Respiratory diseases	Calves	67	. . .	2	. . .	19	11	1
Multiple systems problems	Cows	72	14	1	2	6	3	2
Respiratory diseases	Young stock	82	4	2	. . .	7	4	1
Respiratory diseases	Cows	78	12	1	1	4	3	1
Reproductive problems	Young stock	. . .	91	. . .	. . .	1	1	7
Undiagnosed disease	Young stock	94	6	. . .	. . .	. . .	. . .	. . .
Diarrhea	Cows	84	. . .	1	1	10	3	1
Lameness	Young stock	39	57	. . .	. . .	1	3	
Eye problems	Cows	. . .	96	. . .	. . .	1	1	2
Tumors	Cows	24	71	1	. . .		1	3
Multiple systems problems	Calves	85	4	2	. . .	3	4	2
Digestive problems	Young stock	88	. . .	1	. . .	7	2	2
All others combined	All groups	41	29	1	1	14	6	8
Overall distribution	All groups	27	51	0.4	4	11	3	3.6

*Each row sums to 100% of the combined cost of each disease category reported in Table 2. †*See* Table 1 for definitions. ‡Includes milk lost only during period of treatment and withholding. §Combination of disease events and prevention expenses. ‖Of the 64% losses to death, 17% resulted from cow deaths and 47% resulted from calves born dead.

during the study. Twenty-two (76%) producers initially responded that they regularly utilized veterinary expertise for reproductive health examinations. Although the same proportion was observed during this study, 2 herds were found to be different in acutal use of these services. Twenty-three (79%) producers initially reported that they routinely used veterinarians for herd vaccinations, but only 11 (40%) subsequently did so for reasons other than brucellosis prophylaxis. Producers also recognized veterinarians as a source of biologicals and drugs (41%) and for advice on calf management (21%) and herd nutrition (10%), but the follow-up data did not allow evaluation of actual use of these services.

The proportions of attributable expenses and disease rankings for this study agreed with those found in the 1986 to 1987 California NAHMS dairy herd survey.[10] However, the costs of disease events and prevention were somewhat higher for the study reported here. On a per-herd basis, respective disease costs and prevention costs were $46,740 and $5,796 in this study, compared with $40,674 and $3,991 previously.[10] As experience with NAHMS leads to greater awareness of the spectum of relevant cost components, some of these differences might be explained by improved accounting for health-dollar inputs. Although differences in study design and analysis precluded detailed comparisons, our results also seemed to agree with those of Miller and Dorn in Ohio,[11] together suggesting that approximately 89% of health-related expenses arose from disease events and 11% from disease prevention.

One method of evaluating surveys is to compare the resulting estimates to those from recognized reference sources. For this purpose, the annual statewide whole milk production estimated from NAHMS data (6.6 billion kg) was compared with that reported by the California Department of Food and Agriculture over the same period (8.25 billion kg).[12] Their value was located within the 95% confidence interval of the NAHMS estimate, demonstrating the lack of a statistically significant difference. Although this argues favorably for the representative nature of participating herds, at least with respect to milk production, no statewide surveys exist beyond NAHMS with which to compare disease incidence and costs in California. Furthermore, the errors in monitoring herd-wide milk production are probably minimal in comparison with the limited diagnostic framework of the NAHMS study design and the difficulties in assessing true economic losses. McInerney[13] said that such losses are unlikely to be reliably measured by traditional accounting exercises, a situation apparently compounded by problems in defining the components that should be measured.

The health-related expenditures reported by this survey are intended to estimate only the overt costs of disease in California dairy herds, whereas the true costs are undoubtedly much greater because of subclinical disease and other factors. One apparent source of cost underestimation was the failure of producers to recognize the disease-dependent nature of some cows culled for poor reproductive performance, and the reporting of such cases as typical (nondiseased) management culls instead. This is an area that requires careful attention in future NAHMS surveys.

The NAHMS approach attempts to study random samples of herds to provide estimates that are less biased than those previously available. If extrapolations from these data are reasonable, then the statewide combined cost of overt disease to California dairy producers during 1988 to 1989 was approximately $116 million, $1.66 million of which was attributable to veterinary services. To the extent that NAHMS results are representative of each participating state, NAHMS surveys can be combined to form nationally meaningful estimates, thereby contributing usefully to the accurate economic assessment of livestock diseases throughout the United States.

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Cover artist

Dr. James Harvey Johnson is a veterinary clinical associate in the Department of Veterinary Physiology and Pharmacology at the Texas A&M University College of Veterinary Medicine.

The covers of the mid-month issues of the JAVMA feature animal artwork created by people associated with the veterinary profession (ie, veterinarians and members of their family or staff, veterinary educators, and veterinary students). Those wishing to have their artwork considered for reproduction on the cover of the JAVMA should submit color photographs (identified with the artist's name and relationship to the veterinary profession, address, and daytime telephone number) to Dr. Janis H. Audin, AVMA, 930 N Meacham Rd, Schaumburg, IL 60196.

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Epidemiologic factors, clinical findings, and vaccination status of rabies in cats and dogs in the United States in 1988

Thomas R. Eng, VMD, MPH; Daniel B. Fishbein, MD; the National Study Group on Rabies

Summary: *Despite the availability of rabies vaccination through private veterinarians and government-sponsored rabies control programs, rabies was reported in an average of 338 cats and dogs per year from 1980 through 1987 in the United States. Information was collected on 90% of the 183 cats and 97% of the 119 dogs that were reported to have rabies in the continental United States in 1988. The median age of rabid cats and dogs was 1 year, and 81% were from rural areas. Compared with rabid cats, rabid dogs were more likely to have been male (66 vs 42%, odds ratio = 2.6), to have been kept as pets (84 vs 43%, odds ratio = 6.8), and to have had reported contact with wildlife before onset of illness (38 vs 14%, odds ratio = 3.8). Rabid cats accounted for a greater proportion of human rabies postexposure prophylaxis, bites to people, and exposures to other animals than did rabid dogs. Although the clinical signs of rabies varied, rabid cats were more likely than dogs to have had aggressive behavior (55 vs 31%, odds ratio = 2.8). In contrast, rabid dogs were more likely than cats to have had an illness consistent with a paralytic process. The median period between onset of illness and death was 3 days (range, < 1 to 10) in rabid cats and dogs that were allowed to die of rabies. Vaccine failures were documented in 3 (1%) rabid animals (2 cats and 1 dog). All animals had received only a single dose of vaccine in their lifetime and were vaccinated when they were between 3 and 6 months old.*

Although the most recent human case of rabies attributable to a rabid cat or dog in the United States was reported in 1979,[1] an average of 338 cases of rabies in cats and dogs was reported annually from 1980 through 1987.[2] Approximately half[3] of the estimated 18,000 persons that receive rabies postexposure prophylaxis every year do so because of exposure to rabid cats and dogs.

The most recent epidemiologic studies of rabid cats or dogs in the United States described cases reported from 1971 through 1973 and from 1980

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Presented in part at the 126th annual meeting of the American Veterinary Medical Association in Orlando, Fla, July 1989.

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through 1983.[4,5] However, in both of these studies, a standardized questionnaire was not used to interview the owners of rabid animals, some information was not collected in a timely manner, and case investigations were not always complete.

Systematically collected clinical information on rabies in naturally infected animals in the United States has been limited. In experimental infections, approximately 69% and 37% of rabid cats and dogs, respectively, have aggressive behavior.[6,7]

Although vaccine manufacturers are required to test the potency of rabies vaccines before release, a formal surveillance system for rabies vaccine failures in animals does not exist, and it is unclear how well rabies vaccines perform in the field. In 1988, 24 rabies vaccines were approved by the USDA for use in cats or dogs or both.[8] The USDA requires that licensed vaccines protect at least 86% of vaccinated laboratory dogs or cats and that at least 80% of unvaccinated controls die after inoculation with live rabies virus.[9]

The purpose of the study reported here was to compare the epidemiologic factors, clinical findings, and incidence of vaccine failures in rabid cats and dogs in 1988.

Methods

In 1987, all state health departments that had reported at least one rabid cat or dog to the Centers for Disease Control (CDC) in the preceding 3-year period were contacted. Each state was asked to prospectively provide information on all laboratory-confirmed cases of rabies in cats and dogs diagnosed between Jan 1 and Dec 31, 1988. A laboratory-confirmed case was defined as one involving an animal with a positive direct fluorescent antibody test result of brain tissue or rabies virus isolation in mice or in tissue culture. After laboratory confirmation, personnel from local or state departments of health or agriculture used a standardized questionnaire to interview the owners of rabid animals. When owners could not be identified, the person who submitted the animal for testing was interviewed. If a veterinarian examined the animal, he or she was also interviewed. Almost all questionnaires were completed several days to a few weeks after laboratory diagnosis. The questionnaire elicited information on demographics, clinical signs of rabies, rabies vaccination history, potential risk factors for rabies, and rabies postexposure prophylaxis for persons associated with each animal. A true exposure to rabies was defined as either a bite from a rabid animal or contamination of an open wound or mucous membrane with saliva from a rabid animal. Observed contact with another animal was defined as the respondent having observed the cat or dog playing or fighting with another animal. An unrestrained animal was defined as one that was not confined indoors or physically restrained either in a pen or on a leash. An unexplained lameness or wound was defined as a lameness or wound for which the owner was not able to give a specific cause. A vaccine failure was defined as a case in which a rabid animal had been vaccinated with a licensed rabies vaccine between 1 and 12 months before onset of illness if a vaccine of 1-year duration was used, or between 1 and 36 months if a vaccine of 3-year duration was used.

After initial data analysis, persons associated with rabid animals that were reported to be without clinical signs of rabies or with animals reported to have had current vaccinations were reinterviewed to confirm and clarify information. All questionnaires were analyzed at CDC.

Data on the geographic and seasonal distribution of rabid cats and dogs were abstracted from the database used to generate the annual rabies surveillance report published by CDC, because this database had these data for all reported cases in 1988.[10]

To examine trends in characteristics of rabid dogs, we compared our data with that reported in the 2 most recent studies of rabid dogs in the United States.[4,5]

Statistical tests used for data analysis included the χ^2 square test, the Wilcoxon rank sum test, and the Cornfield approximation for calculating 95% confidence intervals (CI) for odds ratios (OR).

Results

Epidemiologic factors—In 1988, 183 cases of rabies in cats and 119 cases in dogs were reported in the continental United States. Complete information was obtained on 165 (90%) rabid cats and 115 (97%) rabid dogs. The south Atlantic, north central, south central, and mid-Atlantic states accounted for 90% of all cases in cats (Fig 1). The geographic distribution of rabid dogs was similar, with 84% of cases reported from states in the south central, north central, and south Atlantic regions of the United States. Rabies in cats was most commonly reported from June through October, whereas rabies in dogs appeared to have a bimodal distribution, with most cases diagnosed from March through May and from October through December (Fig 2).

The age distribution of rabid cats and dogs was not statistically different (Wilcoxon rank sum test, $P = 0.12$); the median age of rabid cats (range, < 1 to 11) and dogs (range, < 1 to 14) was 1 year (Table 1). Forty-one percent of animals were < 1 year old and 77% were < 3 years old. Rabid dogs were significantly more likely to be male than were cats (OR = 2.6, 95% CI = 1.5, 4.7). The proportions of neutered rabid cats and dogs were low. Rapid dogs were significantly more likely to have been pets than were cats; 84% of dogs were pets compared with only 43% of cats (OR = 6.8, 95% CI = 3.6, 12.9). A number of animals were not considered as pets or strays but as "barn" or "farm" animals. A higher proportion of dogs were from rural areas, and the distribution of cats and dogs by the type of environment where the animal resided was almost

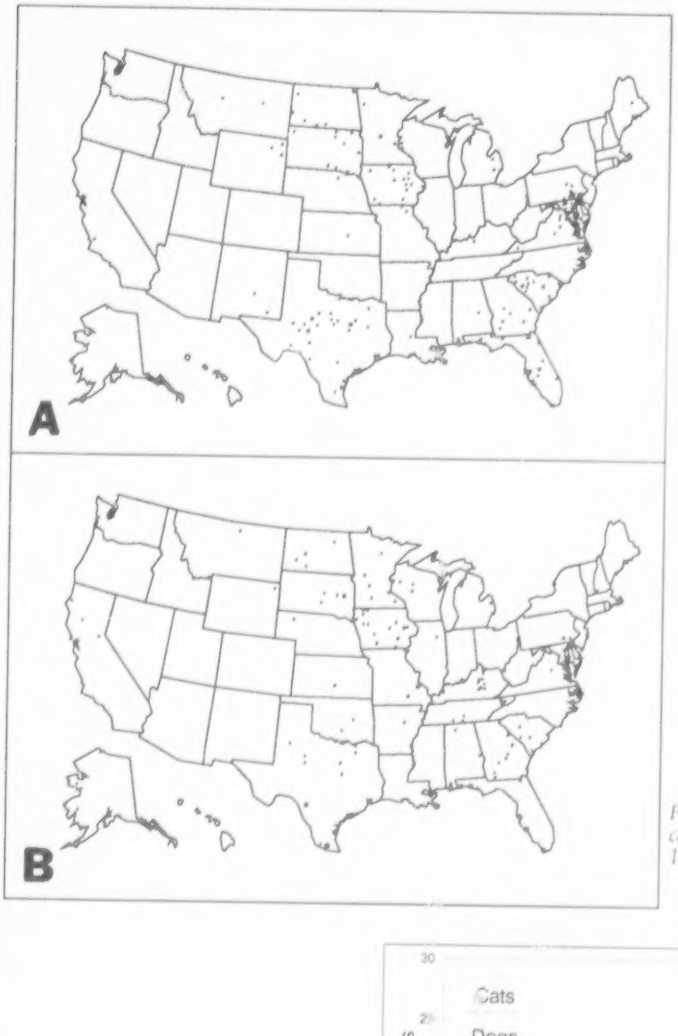

Figure 1—Geographic distribution of rabid cats (A) and dogs (B) in the United States, 1988.[10]

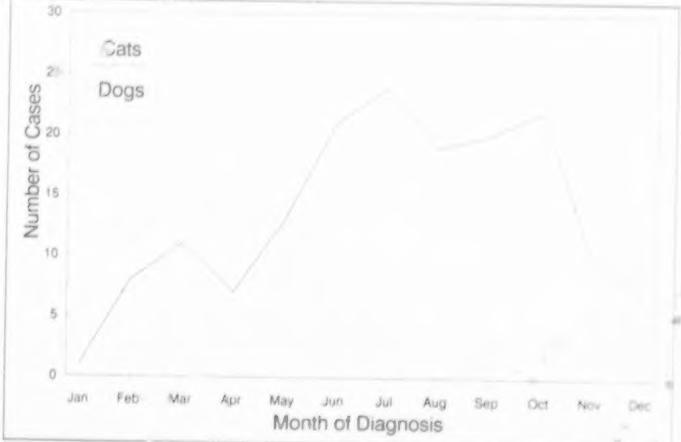

Figure 2—Distribution of rabid cats and dogs by month of diagnosis, 1988.[10]

statistically different ($\chi^2 = 7.34$, 3 df, $P = 0.06$). Only 1% of all cats and dogs confirmed as rabid were found dead on roads. Rabies was confirmed by direct fluorescent antibody testing in (245) rabid cats and dogs and by virus isolation in 4.

In the 6-month period before the onset of illness, owners of rabid dogs (ie, pets and barn animals) were more likely than owners of cats to have observed the animal in contact with a wildlife species susceptible to rabies (38% vs 14%, respectively, OR = 3.8, 95% CI = 1.7, 8.6; Table 2). Skunks accounted for most of the observed contacts with wildlife. A small proportion of animals had contact with a previously confirmed rabid animal.

Most rabid cats and dogs were not restrained

Table 1—Characteristics of rabid cats and dogs

Characteristic	No. (%) of:		
	Cats	Dogs	Total
Age (yr)			
< 1	53 (39)	40 (43)	93 (41)
1	32 (24)	13 (14)	45 (20)
2	25 (19)	12 (13)	37 (16)
3	11 (8)	6 (6)	17 (7)
4	6 (4)	5 (5)	11 (5)
5	5 (4)	3 (3)	8 (3)
> 5	3 (2)	15 (16)	18 (8)
Gender			
Male	50 (42)	67 (66)	117 (53)
Female	68 (58)	35 (34)	103 (47)
Neuter status			
Neutered	6 (5)	6 (7)	12 (6)
Not neutered	106 (95)	85 (93)	191 (94)
Ownership status			
Pet	69 (43)	91 (84)	160 (59)
Stray	73 (45)	11 (10)	84 (31)
"Barn" or "farm"	20 (12)	7 (6)	27 (10)
Type of environment			
Rural	122 (78)	88 (85)	210 (81)
Suburban	27 (17)	7 (7)	34 (13)
Urban	5 (3)	7 (7)	12 (5)
Other	3 (2)	2 (2)	5 (2)
Manner of death			
Euthanatized	136 (86)	83 (74)	219 (81)
Died naturally	22 (14)	26 (23)	48 (18)
Road kill	1 (<1)	3 (3)	4 (1)
Veterinary care			
Yes	[illegible]4 (46)	79 (72)	153 (57)
No	[illegible] (54)	31 (28)	117 (43)
Vaccination status			
Current	2 (1)	2 (2)	4 (1)
Expired	6 (4)	14 (12)	20 (7)
Never vaccinated	97 (59)	76 (66)	173 (62)
Unknown	60 (36)	23 (20)	83 (30)

Cases for which the information was unknown were not included.

Table 2—Characteristics of owned and stray rabid cats and dogs in the six-month period before onset of illness

Characteristic	No. (%) of:		
	Cats	Dogs	Total
Owned animals			
Reported contact with			
Skunk	8 (9)	29 (31)	37 (21)
Raccoon	1 (1)	3 (3)	4 (2)
Other wild animal*	3 (4)	4 (4)	7 (3)
Confirmed rabid animal	1 (1)	3 (3)	4 (2)
Unrestrained outdoors	82 (99)	58 (64)	140 (80)
Unrestrained at night	72 (87)	67 (77)	139 (82)
Missing for 24 hours	21 (28)	17 (20)	38 (23)
Unexplained lameness	19 (23)	19 (22)	38 (22)
Unexplained wound	17 (20)	18 (20)	35 (20)
Used for hunting	1 (1)	13 (14)	14 (8)
Foreign travel	0 (0)	2 (2)	2 (1)
Stray animals			
Previously seen	46 (69)	7 (70)	53 (69)
Fed regularly	24 (38)	5 (56)	29 (40)
Wearing collar	2 (3)	0 (0)	2 (2)
Area where captured			
Residential	38 (53)	3 (30)	41 (50)
Agricultural	21 (29)	4 (40)	25 (30)
Recreational	5 (7)	0 (0)	5 (6)
Commercial	2 (3)	2 (20)	4 (5)
Other	6 (8)	1 (10)	7 (9)

*Three cats had contact with 2 wild cats and 1 unidentified wild animal, and 4 dogs had contact with 2 coyotes, 1 bobcat, and 1 groundhog, respectively.
Cases for which the information was unknown were not included.

when outdoors or at night (Table 2). Cats were more likely than dogs to have been unrestrained when outdoors (OR = 46.7, 95% CI = 6.5, 177.6). Similar proportions of cats and dogs were reported missing for at least one 24-hour period, and similar proportions were reported to have had a wound or lameness of unknown cause. Only 2 animals had been exposed outside of the United States, both of which were pups imported from Mexico.[10,11]

Among rabid animals considered to be strays, a large proportion were familiar in the community and many had routine contact with people (Table 2). For example, 69% of stray animals were previously seen in the community and 40% were fed on a regular basis by someone in the community. Few of the stray animals were wearing collars when they were captured and most were captured in residential or agricultural areas.

Human rabies postexposure prophylaxis was given as a result of possible exposure to 86% of rabid cats and 79% of rabid dogs (Table 3). Rabid cats were more likely than dogs to have bitten a person (OR = 2.8, 95% CI = 1.6, 5.0). The proportion of nonbite exposures (ie, scratches or licks on an open wound or mucous membrane) to rabid cats or dogs were similar. There was no significant difference in the proportion of these animals that exposed other animals. At least 795 persons re-

Table 3—Exposures to people and other animals by rabid cats and dogs

Exposures to	Cats	Dogs	Total
People			
No. (%) of rabid animals that			
Resulted in postexposure prophylaxis	137 (86)	85 (79)	222 (83)
Bit a person	93 (62)	35 (36)	128 (52)
Scratched or licked a person	49 (39)	32 (37)	81 (38)
Median No. (range) of persons vaccinated per rabid animal	1 (0 to 18)	2 (0 to 21)	2 (0 to 21)
No. (%) of vaccinated persons that			
Were bitten	146 (33)	48 (13)	194 (24)
Were scratched or licked	169 (39)	196 (55)	365 (46)
Median No. (range) bitten per animal	1 (0 to 13)	0 (0 to 5)	1 (0 to 13)
Median No. (range) scratched or licked	1 (0 to 11)	1 (0 to 21)	1 (0 to 21)
Other Animals			
No. (%) of rabid animals that exposed other animals	89 (68)	54 (66)	143 (67)
Median No. (range) of other animals exposed per rabid animal	2 (0 to 67)	1 (0 to 37)	2 (0 to 67)

Cases for which the information was unknown were not included.

ceived postexposure prophylaxis as a result of exposures to the 267 rabid cats and dogs for which the information was available. Extrapolation of this rate to the 302 reported cases of rabies in cats and dogs in 1988 indicates that approximately 900 persons in the United States received postexposure prophylaxis because of confirmed rabies in cats and dogs. Although contact with each rabid animal usually resulted in the prophylaxis of only 1 or 2 persons, in one case, a single rabid cat exposed 21 persons. Seventy-percent of patients who received postexposure prophylaxis had true exposures to rabies. At least 779 other animals were exposed by rabid cats and dogs. Although one rabid cat exposed at least 67 other farm animals, the number of animals exposed by rabid cats was not significantly different from that of dogs (Wilcoxon rank sum, $P = 0.12$).

Clinical findings—Rabid dogs were more likely to have been taken to a veterinarian for their illness than were rabid cats (OR = 3.0, 95% CI = 1.7, 5.6; Table 2). The initial diagnoses of veterinarians who examined these animals were similar among cats and dogs (Table 4). Although rabies or "possible rabies" were the most common diagnoses, these were considered to be the primary diagnoses by less than half of veterinarians at the time of examination.

Table 4—Initial diagnoses by veterinarians who examined rabid cats and dogs

Diagnosis	No. (%) of		
	Cats	Dogs	Total
Rabies	17 (23)	18 (23)	35 (23)
Possible rabies	16 (22)	18 (23)	34 (22)
CNS disorder	5 (7)	4 (5)	9 (6)
Trauma	5 (7)	1 (1)	6 (4)
Poisoning	1 (1)	4 (5)	5 (3)
Other	9 (12)	12 (15)	21 (14)
None or unknown	21 (28)	22 (28)	43 (28)
Total	74	79	153

Reported signs in rabid animals ranged from fairly specific findings of rabies, such as jaw and limb paralysis, to nonspecific findings such as fever and lethargy (Table 5). Of the 251 animals for which at least one sign was reported, the only sign in most rabid cats or dogs was aggressiveness in cats. Several clinical findings in cats and dogs were significantly different (Table 5). Rabid cats were more likely than rabid dogs to have had aggressive behavior. In contrast, rabid dogs were more likely than rabid cats to have had ataxia, anorexia, lethargy, excessive salivation, dysphagia, limb and jaw paralysis, and fever.

Thirteen (8%) cats and 6 (5%) dogs were reported to be without clinical signs of rabies during their illness. However, of these 19 animals, 9 were stray animals, 6 were pets that were not closely observed during their illness, 2 actually had clinical signs, and 1 was found dead on a road. The owners of the remaining animal were not available for a second interview.

To examine the course of naturally acquired rabies infection, we reviewed the records of the 15 cats and 22 dogs that had been allowed to die of rabies and had a known date of onset. The median interval from onset of signs to the date of death was 3 days in both cats and dogs; all animals except 2 (95%) died within 7 days after onset of illness (Fig 3). One cat, however, died on the tenth day of illness.

Vaccination status—Most rabid cats and dogs were never vaccinated (Table 2). Assuming that animals of unknown vaccination histories were probably never vaccinated, only 5% and 14% of rabid cats and dogs, respectively, had ever been vaccinated. Rabid dogs were more likely to have been vaccinated than were cats (OR = 3.2, 95% CI = 1.2, 8.4). Only 4 (1%) cats and dogs had a current vaccination. Of these, 2 cats and 1 dog were vaccinated at least 1 month before onset of illness and their cases were considered vaccine

Table 5—Clinical findings in rabid cats and dogs

Sign	No. (%) of			OR [95% CI]
	Cats	Dogs	Total	
Aggressiveness	81 (55)	32 (31)	113 (45)	2.8 [1.6, 4.9]*
Ataxia	44 (30)	51 (49)	95 (38)	0.4 [0.3, 0.8]*
Irritability	50 (34)	24 (23)	74 (29)	1.7 [0.9, 3.2]
Anorexia	32 (22)	39 (38)	71 (28)	0.5 [0.3, 0.8]*
Lethargy	29 (20)	38 (37)	67 (27)	0.1 [0.1, 0.3]*
Excess salivation	20 (14)	43 (41)	63 (25)	0.2 [0.1, 0.4]*
Hyperexcitability	38 (26)	21 (20)	59 (24)	1.4 [0.7, 2.8]
Restlessness	34 (23)	25 (24)	59 (24)	1.0 [0.5, 1.8]
Dysphagia	15 (10)	31 (30)	46 (18)	0.3 [0.1, 0.6]*
Lameness	26 (18)	17 (16)	43 (17)	1.1 [0.5, 2.3]
Limb paralysis	25 (17)	30 (29)	55 (16)	0.5 [0.3, 0.96]*
Jaw paralysis	4 (3)	30 (29)	34 (14)	0.1 [0.02, 0.2]*
Change in voice	24 (16)	9 (9)	33 (13)	2.1 [0.9, 5.0]
Hyperesthesia	14 (10)	18 (17)	32 (13)	0.5 [0.2, 1.1]
Seizure	12 (8)	14 (14)	26 (10)	0.6 [0.2, 1.4]
Scar/open wound	15 (10)	9 (9)	24 (10)	1.2 [0.5, 3.1]
Fever	4 (3)	14 (14)	18 (7)	0.2 [0.1, 0.6]*
Photophobia	1 (1)	1 (1)	2 (1)	0.7 [0.02, 26.1]
Other	24 (15)	25 (23)	49 (18)	0.6 [0.3, 1.2]

*Indicates a statistically significant difference.
Cases for which the information was unknown were not included.
OR = odds ratios; CI = confidence intervals.

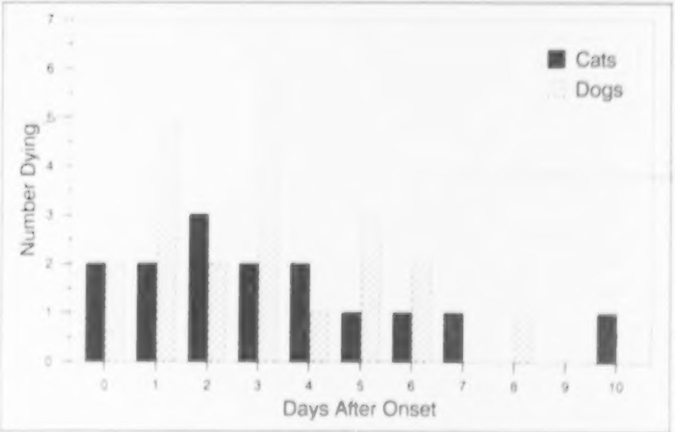

Figure 3—Interval from onset of illness to day of death in rabid cats and dogs allowed to die naturally.

Table 6—Rabies vaccine failures in rabid cats and dogs

Type of vaccine	Species	Route	Total doses	Age at vaccination	Period before onset*
PM-HKTC,† 1-yr	Cat	IM	1	3 mo	9 mo
SMBV,‡ 1-yr	Cat	IM	1	3.5 mo	4.5 mo
SMBV, 1-yr	Dog	IM	1	6 mo	1 mo

*Interval from date of vaccination to onset of rabies; †Pitman-Moore strain, hamster kidney tissue culture; ‡Suckling mouse brain vaccine.

failures (Table 6). All 3 animals were vaccinated when they were between 3 and 6 months old and had received only a single dose of vaccine in their lifetime. All vaccines associated with these failures were killed vaccines. The only vaccine implicated more than once was a suckling mouse brain vaccine (SMBV) produced by the same manufacturer but from 2 different lots. These 2 lots had National Institutes of Health relative potency values of 3.8 or 4.2 (2 tests were run on this lot) and 6.1 when released from the manufacturer. The lot number of the other vaccine was not available. All animals were vaccinated intramuscularly by licensed veterinarians.

Trends in characteristics of rabid dogs—Assuming the dog population is relatively constant, the incidence of reported rabid dogs decreased steadily from 1971 to 1988 (Table 7). Although rabid dogs in 1988 seemed to be younger than dogs in 1971 through 1973, this difference was not statistically significant ($\chi^2 = 5.26$, 2 df, $P = 0.07$). The proportion of owned dogs or dogs with aggressive behavior were similar among the 3 study periods. However, a higher proportion of rabid dogs reported in 1988 (14%) had a current or expired vaccination than those reported in 1971 through 1973 (9%; OR = 1.5, 95% CI = 0.8, 2.9). Although the difference was not statistically different, the likelihood of vaccine failures in 1971 through 1973 was several-fold higher than in 1988 (OR = 4.8, 95% CI = 0.7, 95.8).

Table 7—Comparison of rabies in dogs reported in 1971 through 1973, 1980 through 1983, and 1988

	No. (%) of rabid dogs reported in:		
Characteristic	1971-73	1980-83	1988
Average No. cases per year	210	178	119
Age (yr)			
< 1	77 (30)	*	40 (43)
1 to 3	111 (43)	*	31 (33)
> 3	70 (27)	*	23 (24)
Ownership status			
Owned	396 (87)	261 (80)	98 (90)
Stray	59 (13)	67 (20)	11 (10)
Aggression	79 (26)	113 (33)	32 (31)
Vaccination status			
Current	34 (6)	†	2 (2)
Expired	16 (3)	†	14 (12)
Never	331 (63)	246 (71)	76 (66)
Unknown	134 (25)	70 (20)	23 (20)
Vaccine failures	21 (4)	*	1 (<1)

*Data was not available. †Thirty dogs (9%) were previously vaccinated, but the proportion of dogs that were currently vaccinated was not available.

Discussion

Epidemiologic factors—The seasonality of rabies infection in cats and dogs in the United States seems to be related to seasonal increases in rabid wild animals. The peaks of rabid dogs reported during the spring and fall were consistent with reported increases in rabid skunks and raccoons during these periods.[10] Although the summertime increase in rabid cats was similar to the seasonal increase in rabid bats,[10] monoclonal antibody typing of rabies virus isolates from bats suggest that bats are rarely the source of infection for cats and other terrestrial animals.[12] In developing countries, seasonal increases in rabid dogs are mainly a result of increased mating activity.[13]

The large proportion of young rabid cats and dogs is probably related to either increased susceptibility of young animals to rabies infection[14] or increased risk of exposures to rabies or both. Young animals are usually more active and presumably have more frequent contact with other animals than older animals. Information on the age distribution of the general cat and dog population was not available. Overrepresentation of young age groups among rabid animals has been reported in many developing countries.[15]

It is unclear why rabid dogs were predominantly male and rabid cats were predominantly female. This observation may simply be related to the gender distribution of cats and dogs in the general population (data were unavailable).

Although we found that rabid dogs were more likely than cats to have been pets, the ratio of pet cats and dogs to strays in the United States is unknown. The small percentage of reported rabid animals that were killed on roads probably is related to the fact that many state health departments do not test animals that are not associated with human or animal exposure.

Almost all rabid cats and dogs were reported from areas where rabies in wildlife species, especially skunks and raccoons, was enzootic.[10] Because almost a third of rabid dogs were observed in direct contact with a skunk within the 6-month period before illness, skunks are probably the major source of rabies for dogs in the United States. Dogs were more likely than cats to have had reported contact with wildlife, but this difference was probably attributable to the fact that dogs are generally better supervised than cats. A study of the mid-Atlantic raccoon epizootic during 1982 and 1983 revealed similar findings; 247 rabid raccoons had exposed dogs, compared with only 12 rabid raccoons that had exposed cats.[16] Therefore, animals that have been observed to have direct contact with wildlife species known to transmit rabies, such as skunks and raccoons, should be euthanatized if the animal does not have a current rabies vaccination unless area-specific surveillance data clearly indicate no rabies activity in the wildlife species.

Although most rabid cats and dogs were unrestrained at night or when outdoors, it is unknown how often cats and dogs in the general population are unrestrained. However, it is likely that these are risk factors for rabies. The finding that rabid cats were more likely to be unrestrained than rabid dogs can be attributed to the fact that cats are generally less likely to be restrained. A history of unexplained lameness or wounds was reported in a relatively large proportion of rabid cats and dogs and may have resulted from encounters with wild animals.

Most stray rabid cats and dogs were familiar to and had routine contact with people in the community. Many of these animals, therefore, may be more accurately described as community animals. The role of community animals in the transmission of rabies has been well described in developing countries.[17]

We found that, of approximately 900 people exposed to confirmed rabid cats or dogs in 1988, approximately 70% (630) had true exposures to rabies; therefore, 30% of postexposure prophylaxis regimens given as result of possible exposure to rabid cats and dogs may have been unnecessary. Therefore, only approximately 4% of the estimated 18,000 persons a year that receive postexposure prophylaxis do so as a result of true exposures to confirmed rabid cats and dogs. Helmick estimated that, from 1980 through 1981, 31% of people in the United States who received postexposure prophylaxis for exposures to cats or dogs were exposed to a confirmed rabid animal.[3]

If the cost of rabies postexposure prophylaxis is conservatively estimated at $514/patient (ie, $458 for the cost of the biologics and $56 for medical office fees),[18] the cost of administering postexposure prophylaxis to people exposed to all confirmed rabid cats and dogs in 1988 was approximately $462,000. Other substantial costs associated with these rabid animals include expenses involving the treatment of bite injuries, lost wages from work, and the destruction of other animals exposed to these rabid animals.

Rabies vaccination programs need to target cats as well as dogs. In 1988, cats became the most commonly reported rabid domestic animal for the first time.[10] Moreover, rabid cats are the cause of more human exposures to rabies than dogs. Rabid cats were more likely than dogs to have bitten people, probably because of the increased likelihood of aggressive behavior in rabid cats.

The study population, laboratory-confirmed rabid cats and dogs, was probably representative of all rabid cats and dogs that caused human or domestic animal exposure. However, because many state health departments tested only animals suspected of being rabid that were associated with human or animal exposures, rabies in animals that did not have contact with people or domestic animals was probably undercounted. Rabid animals that resulted in human or domestic animal exposures but escaped were also not represented in our study population.

Clinical findings—Although more rabid dogs than cats were taken to veterinarians, a higher proportion of rabid dogs were owned, and dog owners are more likely than cat owners to obtain veterinary care.[19] Veterinarians should be made more aware of the signs of rabies; most veterinarians who examined rabid cats and dogs in 1988 did not suspect rabies as their initial diagnosis. The 2 imported cases of rabies, one of which was imported into New Hampshire, illustrate the need to consider the possibility of this disease even in areas free of terrestrial animal rabies. The apparent relative difficulty of the clinical diagnosis of rabies may be largely attributable to the variability in clinical signs of disease and to the popular misconception that both rabid cats and dogs are usually aggressive. The clinical behavior of rabid cats is likely to be aggressive and irritable. We found that 55% of naturally infected cats had aggressive behavior, compared with 69% of experimentally infected cats.[6] Rabid dogs, on the other hand, were more likely to have signs suggestive of a paralytic process such as lethargy, limb and jaw paralysis, and ataxia. The increased likelihood of aggressive behavior in rabid cats compared with dogs has been reported from other countries.[20,21] The proportion of dogs with aggressive behavior in our study (31%) was similar to that of dogs experimentally infected with rabies (37%).[7]

Although a large number of rabid cats and dogs were reported to be without clinical signs of rabies, we were not able to confirm any closely observed animal that was truly without clinical signs, and it is unlikely that infections without clinical signs develop in naturally infected cats and dogs in the United States. Although nonfatal rabies infections without clinical signs have been reported in naturally infected dogs from developing countries and in experimentally infected dogs,[22,23] this phenomenon is extremely rare.[24]

Our data support the recommended 10-day quarantine period for suspect rabid cats and dogs in the United States.[25] In our study, all rabid cats and dogs died within 10 days after onset of illness. The median length of clinical illness in naturally infected rabid cats and dogs (both 3 days) was similar to that reported for experimentally infected cats (5 days) and dogs (3 days).[6,7]

Vaccine failures and efficacy—The proportion of rabid cats or dogs that had a history of rabies vaccination was extremely low, but rabid cats were even less likely to have been vaccinated than dogs. This finding is probably related to the lower levels of veterinary care[19] and vaccination in cats than in dogs in the general population.

Although rabies vaccines in the United States for cats and dogs apparently have a low failure rate, it is unclear what proportion of vaccinated animals are actually exposed to rabid animals. Indeed, it is likely that vaccinated animals, which tend to be from urban areas and may be better supervised, are less likely to be exposed to rabies than unvaccinated animals.

The reasons for the 3 vaccine failures are unclear. However, each animal had been given only one dose of vaccine in its lifetime. Undoubtedly, the likelihood of an adequate immune response increases with subsequent vaccinations. The cases of rabies in animals that had been previously vaccinated, but whose vaccinations were not current, emphasizes the importance of adhering to revaccination schedules. All animals had been vaccinated when they were between 3 and 6 months old. Although the recommended minimum age for rabies vaccination for cats and dogs is 3 months,[8] dogs vaccinated at a later age seem to respond better than those vaccinated earlier. In one study, dogs vaccinated when they were between 9 and 12 weeks old had antibody titers several-fold higher than dogs vaccinated when they were between 6 and 9 weeks old.[26] Postponing the initial rabies vaccination to a later age, however, would probably decrease vaccination coverage because of the loss of opportunity to administer rabies vaccinations around the time of other routine immunizations, which are given before the animal is 6 months old. Because the median age of rabid cats and dogs is 1 year, animals that have not yet completed their primary seies are at high risk for rabies. Therefore, if vaccine studies can demonstrate adequate seroconversion and protection by administering the primary series (2 vaccinations) before the animal is 6 months old, such a schedule may be more effective than administering the second vaccination 1 year after the initial vaccination. In addition, administering the primary series in conjunction with other routine immunizations may increase vaccination coverage.

Although 2 of the vaccines associated with failure were SMBV made by the same manufacturer, they were not related to the same production lot. The high relative potencies of the lots of SMBV at the production facility suggest that the vaccine lots were inherently immunogenic. We were unable to determine whether the vaccines were mishandled in the field.

The incidence of vaccine failures and the efficacy of rabies vaccines could not be accurately assessed because the number of cats and dogs vaccinated per year in the United States was not available. The most recent estimate of the cat and dog populations in the United States was 54,583,000 owned cats and 52,359,000 owned dogs in 1987.[19] In 1988, according to USDA records, 33,182,575 doses of rabies vaccine for all animals were produced and released for distribution by vaccine manufacturers in the United States.[27] Although the quantity of vaccine actually used, the quantity of vaccine exported to other countries, and the proportion of vaccine used by species were unknown, it is likely that most of the vaccine produced was used to vaccinate cats and dogs in the United States. Thus, the maximal proportion of owned cats and dogs vaccinated in 1988 would be approximately 31% (33,182,575/106,942,000). Although the proportion of vaccinated animals that were exposed to rabies was unknown, given the large number of doses produced and the few vaccine failures documented in 1988, the efficacy of rabies vaccines seems to be extremely high.

Trends in characteristics of rabid dogs—The reasons for the decrease in rabies in dogs in 1988 compared with earlier periods were unclear; however, the higher prevalence of previously vaccinated rabid dogs in 1988 suggests that vaccination levels in dogs have increased. The lower rate of vaccine failures in 1988 compared with 1971 through 1973 suggests that rabies vaccines have improved or the risk of rabies in dogs has decreased, or both, during the intervening 15 years.

Our findings support the current recommendations for animal rabies control.[8–25] Current rabies control measures, especially vaccination of animals, have been highly effective in reducing the risk of rabies transmission from domestic animals in the United States. Given the various wildlife reservoirs of rabies in the United States and the fact that complete vaccination coverage in cats and dogs is virtually impossible to attain, it is unlikely that rabies in cats and dogs will be eliminated in this country. From a cost-benefit perspective, elimination of rabies in animals may not be desirable. Although rabies vaccines are highly effective, revaccination at recommended intervals are necessary. A positive history of vaccination does not preclude the possibility of rabies infection, especially if the animal has been vaccinated only once.

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Horses by a Pond is a 19-inch × 29-inch oil-on-canvas painted by British artist S. Joseph Clark circa 1860. Another painting by Clark, *Carthoses Drinking from a Brook*, was featured on the Nov 1, 1989 cover of the JAVMA.

Permission to reproduce the painting on this issue's cover was granted by Feigen, Inc of Chicago.

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Special Commentary

Specialization in veterinary medicine: Where we've been and where we're going

John F. Fessler, DVM, MS; James K. Burt, DVM, MS; Richard R. Brown, DVM

Specialization is coming of age in veterinary medicine. By the year 2000, specialties will evolve as an important component of veterinary service to the consuming public, with referrals, consultations, and primary, secondary, and tertiary levels of patient care similar to that of human medicine today. In fact, the knowledgeable consumer will expect nothing less.

Specialists have been a part of the educational and institutional practice of veterinary medicine for several decades. Now, they are providing an evolving, maturing, ever-expanding component of private veterinary practice as well. The influx of specialists to private practice is viewed as desirable for the future, but it has the potential to create a disparate conglomeration of organizations representing bonified specialties, subspecialties (affiliates), pseudo-specialties, and special interest groups. The setting could become adversarial, compared with collegial, with a splintering of the profession and a detraction from quality assurance to the public. This would be a serious threat to a small profession that deals with multiple species as well as the usual medical disciplines and body systems, all in a tightly restricted economic framework. All veterinarians need to be informed about the current status of specialization in the profession, the historical developments, and the trends as they are evolving so that future actions and decisions can be informed, can reflect the body politic, and can result in consumer services that are in demand.

Specialization surfaced in 1950 when the AVMA Executive Board received applications for recognition from the first 2 speciality organizations, the American College of Veterinary Pathologists (Feb 10, 1950) and the American Board of Veterinary Public Health (July 31, 1950). In 1951, the AVMA House of Representatives approved the recognition of these 2 colleges and assigned the responsibility for future applications to the Council on Education. In 1957, the House of Representatives granted recognition to the American College of Laboratory Animal Medicine. The impetus for these early specialties, no doubt, was interest by veterinarians and demand by the public; now these 3 colleges are large, well-organized, influential groups in the profession.

The Council on Education subsequently recommended the establishment of the Advisory Board on Veterinary Specialties (ABVS). It met for the first time in 1960 and has been guiding the development and approval of the various colleges and boards ever since. The ABVS meets annually and is composed of delegates from each of the AVMA-recognized specialty organizations and a representative from the Council on Education. The ABVS exists for the expressed purposes of: furnishing advice and assistance to organizations submitting petitions for establishment and recognition as a specialty; evaluating and establishing criteria for specialty boards and determining that they meet the criteria, fill a recognizable need, and represent distinct specialization in veterinary medicine; and promoting and encouraging the enhanced utilization and availability of specialty services within the profession and to the public.[1] In carrying out these objectives, the ABVS reviews applications and reports, makes recommendations to the Council on Education, which are ratified by the House of Delegates, and serves as a mediator in disputes. In the past 30 years, the ABVS has been busy. It has grown from an initial committee of 3 to the present size of 19 members as represented by a delegate from each of the currently approved colleges and boards (Table 1) and a scientific advisor from the AVMA staff.

The strongest growth in colleges and boards has been in the clinical specialties. Just under 10% of all AVMA members are board-certified, but the number is growing rapidly. A singular motivation for obtaining board certification in a clinical specialty in the 1970s and early 1980s was the career goal of a faculty position. During that era, older veterinary schools were expanding, and newer schools were being established. There was a scramble for clinical faculty, and residency training with board certification was viewed as PhD-equivalent preparation for academe. Now, the expansion era

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From the Committee to Promote Specialty Services, Advisory Board on Veterinary Specialties, AVMA. The ABVS has reviewed and endorsed this special commentary.

Table 1—Currently approved specialty colleges and boards

Name	Full Approval	Membership
Am Board of Vet Practitioners	1985	261
Certification in Companion Animal Practice		
Certification in Equine Practice		
Certification in Food Animal Practice		
Certification in Dairy Practice		
Certification in Feedlot/Cow-Calf Practice		
Am Board of Vet Toxicology	1970	77
Am College of Lab Anim Medicine	1957	379
Am College of Theriogenologists	1975	248
Am College of Vet Anesthesiologists	1981	85
Am College of Vet Dermatology	1986	47
Am College of Vet Int Medicine	1980	463
Certification in Cardiology	1980	
Certification in Neurology	1980	
Certification in Oncology	1988	
Am College of Vet Microbiologists	1968	219
Certification in Virology	1988	
Certification in Immunology	1988	
Certification in Bacteriology/Mycology	1988	
Am College of Vet Nutrition	1988 (provisional)	26
Am College of Vet Ophthalmologists	1974	126
Am College of Vet Pathologists	1951	965
Am College of Vet Preventive Medicine	1951	483
Certification in Epidemiology		
Am College of Vet Radiology	1966	132
Am College of Vet Surgeons	1970	394
Am College of Zoological Medicine	1988	22
Am Vet Dental College	1988 (provisional)	18
Am College of Vet Emergency and Critical Care	1989 (provisional)	19
Am College of Vet Clinical Pharmacology	1990 (provisional)	5

is over, and faculty positions are saturated. Yet, the interest in residency training and board certification persists for a variety of reasons: the ever-expanding volume and complexity of scientific information mandates a focused approach to career development; new graduates are seeking internships and residencies as suitable job opportunities in the professional pipeline; practitioners and the public are becoming increasingly suave about consultation and referrals, particularly regarding veterinary teaching hospitals and in metropolitan areas[2]; nationally based studies, such as the PEW educational initiative, have focused on specialization as a societally driven trend for the future[3]; board certification is becoming a requirement for certain jobs and/or a higher level of salary (eg, government service); and specialists are leading the way in the research, teaching, publishing, and practice of veterinary medicine. These time-honored signals of professional career development are the role-modeling magnets that attract veterinary students and new graduates to choose certain career paths.

The profession is in transition regarding the role of specialists in service to the public. On one hand, specialists have had the edge over nonspecialists in the faculty job market, but now this traditional opportunity has filled. On the other hand, specialization is here to stay and is forecast to expand.[2,3] Anywhere from 30 to 50% of clinical specialists are in practice and their numbers are growing. These specialists are establishing themselves in metropolitan-based group practices and, increasingly, in isolated solo locations. A strong correlation has been observed between the number of veterinarians working in a particular type of practice and the frequency of referrals to specialists outside that practice.[2] For practices employing 5 or more veterinarians, 70% of such practices refer cases to specialists outside the practice, whereas for practices employing only one veterinarian, only 33% of such practices utilize outside specialists.

A survey in January 1989, indicated that horse owners generally were more likely to be aware of the availability of specialists than were owners of pets or livestock.[4] Horse owners also were more agreeable to using specialists than were the other categories of animal owners. It was apparent from this survey that most people recognize the veterinary specialist because of their familiarity with medical specialties. The respondents in this survey believed that referral of cases would increase by 57% in small animal practice, 50% in food animal practice, and 37% in equine practice during the next 5 years.[4]

Veterinarians situated in densely populated areas tend to refer patients more frequently than do those serving less-populated areas, and without a fear of losing clients to specialists through the referral process.[2] However, the same survey indicated that almost half the respondents believe that the general public does not fully understand the role of specialty practices in the veterinary health scheme, wherein the general practitioner provides primary (preventive) care, clinical specialists in practice provide secondary care via referral, and university faculty members provide tertiary care in the form of research, prospective studies, and expensive technology that has limited availability.

These data indicate that specialty practice is currently alive, well, and growing within the profession, particularly in metropolitan group practices. Yet, though it is growing, many specialists providing secondary care cannot make a living strictly from their referral cases alone. Another problem is that board-certified specialists can locate and are locating in less-urban situations, where there is client reluctance to be referred and fear on the part of primary-level practitioners of losing clients to specialists through the referral process. Specialists in these situations are forced to resort to primary care to make a living, adding to a vicious cycle of referral reluctance. These specialists are at risk of becoming disenchanted by their underutilization and of being over-educated and over-trained for their practice circumstance.

What are some of the issues of and answers to client reluctance and fear of client loss? How do we evolve in a positive, constructive way on behalf of the consuming public and the veterinary profession itself? Education and communication are the keys. Professional and nonprofessional awareness of the advantages of specialty referrals are areas needing emphasis and promotion. Already existent specialty colleges and boards and the AVMA must take the lead. The following are some of the issues and actions that have been taken recently or are under consideration.

In this day and age of marketing, every veterinarian is looking for an "edge," something that will set him/her apart in fostering a practice, suitable career development, and in obtaining personal security. In a profession that deals with multiple species, multiple body systems, and multiple medical disciplines, the distinction between "special interest" and bonafide specialization becomes blurred. A veterinarians's intention to represent his/her skills and knowledge to the public without misrepresentation as a specialist, if indeed he/she is not, leads to some honest mistakes. The fact that recognized specialties based on species, systems, and disciplines now exist has added to the confusion and the blurring of ethical boundaries for advertising. Everyone knows the meaning of "surgeon," "ophthalmologist," or "radiologist," and everyone knows that all DVMs are licensed to perform surgery, examine eyes, and interpret radiographs. The ethical mistake comes from promoting oneself in a species, system, or discipline specialty without appropriate residency training and certification. This is separate and distinct from limiting a practice to a particular species or activity, which has been and continues to be recognized as a professional choice for all licensed veterinarians. For clarification, the ABVS, the Judicial Council, and the House of Delegates of the AVMA recently have adopted guidelines for advertising and definitions for specialists:

A. Advertising and Directory Listings
   1. Veterinarians may legally advertise in any way that is not false, misleading, or deceptive. Advertising guidelines and interpretations are discussed in the AVMA Principles of Veterinary Medical Ethics in the 1990 issue of the AVMA Directory.
   2. Veterinarians should not in any way imply that they are specialists unless they are certified by an AVMA-recognized specialty board or college.
   3. Individual specialty organizations are encouraged to provide guidance to their members in matters pertaining to advertising or directory listing. For example, a diplomate of the American Board of Veterinary Practitioners, certified in companion animal practice, should choose from the following directory listing options:
      a. Diplomate, American Board of Veterinary Practitioners, certified in Companion Animal Practice, or
      b. Diplomate, American Board of Veterinary Practitioners (Companion Animal Practice).

   Or, a diplomate of the American College of Veterinary Internal Medicine certified in Cardiology should choose from the following options:
      a. Diplomate, American College of Veterinary Internal Medicine, certified in Cardiology, or
      b. Diplomate, American College of Veterinary Internal Medicine, (Cardiology).

Approved, AVMA
House of Delegates
July 1988

B. Definitions
   1. SPECIALIST–A veterinarian who is certified by a specialty college or board recognized by the AVMA.
      a. SYSTEM SPECIALIST–A specialist in a field that has its primary emphasis on a specific organ or body system within veterinary medicine (eg, ophthalmology, internal medicine, neurology). This field may involve various species and may involve various medical and/or surgical disciplines within the representative body system or organ, which is the primary area of specialization.
      b. DISCIPLINE SPECIALIST–A specialist in a field that has its primary emphasis on a particular discipline within veterinary medicine (eg, surgery, pathology, virology, radiology, preventive medicine & public health). This field may involve various species and may involve various body systems or organs within the representative discipline that is the primary area of specialization.
      c. SPECIES SPECIALIST–A specialist in a

> field that has its primary emphasis on a particular species or group within a species within veterinary medicine (eg, laboratory animal medicine, zoological medicine, companion animal practice). This field may involve different medical and/or surgical disciplines and may involve various body systems or organs within the representative species that is the primary area of specialization.
>
> Approved, AVMA
> House of Delegates
> July 1989

Conscientious adherence to these guidelines by all veterinarians, generalists and specialists alike, will help to unravel some of the blurring and confusion. A practitioner who limits his/her practice to canine orthopedics cannot advertise as a specialist. By the same token, a diplomate of the American Board of Veterinary Practitioners certified in companion animal practice cannot advertise as a surgeon.

Two different, but somewhat related problems have a bearing on the issues of misrepresentation and advertising, "board qualified/eligible" candidates and Charter Diplomate-status in emerging specialties. Veterinarians are successfully completing residency training programs in various specialties, but for any number of reasons they are failing to submit their credentials, complete the examination, and obtain certification in their respective college or board. These individuals are fully knowledgeable, trained, and experienced and are eminently qualified to take referrals and provide secondary-level service. However, they have not completed the certification process and cannot advertise as a specialist. The same dilemma exists in human medicine where, apparently, "board eligibility" has been viewed as an end point in itself and the physician has no intention of submitting to credentialing and examination. This has resulted in actions by the American Board on Medical Specialties in human medicine and the ABVS in veterinary medicine to disavow use of the terms board-eligible or board-qualified as indications of special qualifications because they are misleading to the public. The mentors of residency training programs would fervently hope that all their residents would complete the certification process, thus seeking the highest level of recognition as a specialist, but this is not the case. Veterinarians who have completed residency training but have not obtained certification will practice their "specialties" as do residency-trained but uncertified physicians. Because board certification is a voluntary process, there is no way to "enforce" completion of the credentialing and examination process in a democratic society.

The issue of granting Charter Diplomate-status has come under considerable scrutiny. Historically, charter status has been granted to professors of the specialty, individuals who have authored important publications resulting from teaching, research, or practice in the specialty and have had at least 10 years experience in the specialty. These Charter Diplomates have been well-known in the profession at large and are unquestioned regarding their motives and academic credibility. Recently, the ABVS has been in the position of having to discriminate between these patriarches of an emerging specialty and those of lesser accomplishments who are seeking the "edge" that was mentioned earlier.

It is axiomatic, with the emergence of any new organization, that someone must lead, and that worthy individuals will be overlooked; such is the nature of change and progress. The very establishment of specialties involves the setting of standards, even for the initiating Charter Diplomates. The responsibility for setting the standards and for making the hard decisions, those that impact on individual careers, begins with the organizing committee of a new specialty. These decisions are approved, modified, or denied by the ABVS. Fortunately, none of the 18 specialties currently in place have been approved expressly for the self-aggrandizement of its members, especially their Charter Diplomates. Quality assurance (ie, the provision of improved veterinary medical services) and the protection of the public from incompetence have been the overriding premises for specialty colleges and boards. Thus in 1989, the ABVS reaffirmed the long-established requirements for Charter Diplomate-status in a newly approved specialty. Such requirements are focused on excellence and expertise in the practice of the specialty, as evidenced by the authorship of important publications, academic title, and extended experience. Veterinarians who qualify as Charter Diplomates are expected to serve on the organizing committee of a new specialty, but not all members of the organizing committee will necessarily be granted Charter Diplomate-status per se. In other words, a veterinarian may contribute to the organization of an emerging specialty, but be premature for Charter Diplomate-status him/herself. Presumably, such individuals would be admitted to one of the earlier examinations when the new college or board was up and running. These reaffirmations and refinements of the definition of an organizing committee and the requirements for Charter Diplomates should improve the fairness and impartiality by which such decisions are made in the future. They are detailed in the Policies and Procedures Manual of the ABVS, which is available by request from the AVMA headquarters.[1]

It would appear that the awareness of specialties is growing among veterinarians and the general public, but their acceptance and utilization is low. Presumably, we are on the threshold of naturally increasing visibility and utilization as the number of board-certified specialists in practice settings increases and the expectations of the general public rise. Dramatic advances in the profession have made it virtually impossible for every veterinarian to remain current with all of the emerging diseases in all species, or to be competent with all of the new techniques and complex instruments that are finding widespread application in veterinary medicine. Cost alone prohibits the universal availability of all knowledge and all technology in each practice setting. In a word, the James Herriot era of practice is over. Every veterinarian recognizes the need and the place for a second opinion; this is the genesis of a consultation or referral.

Communication and trust are the attributions between general practitioners and specialists that will lead to appropriate referrals and the best patient care. As outlined by the Council on Public Relations of the AVMA, the following ideas inculcate communication and trust and are encouraged on behalf of primary and secondary care givers. Primary care veterinarians in a position to refer patients must know about the training and expertise possessed by board-certified specialists and the unique equipment or technology they can provide. When a specialist enters practice in a given area, he/she should send announcements and business cards to the surrounding general practitioners indicating his/her special areas of interest and expertise and invite inquiries. Several of the specialty colleges and boards (medicine, surgery, ophthalmology) have developed brochures that define the qualifications of their members and the services available. There are consortia of board-certified specialists in certain parts of the country. The Ohio Association of Practicing Veterinary Specialists distributes a brochure giving the services, location, and disciplines of their members. The Association of Certified Veterinary Medical Specialists in California provides a toll-free number to support general practitioners and their clients in need of assistance. Such consortia and associations are expected to grow in numbers throughout the country.

Specialists in practice must assure surrounding practitioners that they will provide only specialty care, not routine primary-level veterinary services for the cases referred to them. Soon after the referral, the primary care veterinarian should expect a timely communication from the specialist about the findings, treatment, or procedures that are to be used. The specialist should complete the process by referring the patient back to the general practitioner for any follow-up requirements that befit the primary care setting, thank the practitioner, and reassure the animal's owner about the good judgement and serious concern that was shown by the referring veterinarian. Misunderstanding of expectations for diagnosis and treatment by the primary-care veterinarian and lack of communication and ethical courtesy by the specialist will destroy a potential referral liaison from the outset.

Primary- and secondary-care veterinarians must help themselves, individually and collectively through their local associations, consortia, and specialty colleges and boards, and not wait for national-level initiatives and public announcements. At this time, the specialties are not a large constituency within the AVMA; it would be unreasonable to expect the AVMA to allocate a disproportionate amount of time and resources to the issues of consultation and referral among veterinarians and wrong to expect it to mandate a system for ideal patient care. Such allocations and systems must evolve in the future on the basis of the people and expertise available within the profession and the expectations of the public, not on the basis of a centralized administrative mandate.

On the other hand, there are several initiatives within the AVMA that should foster quality assurance to the public that the veterinary profession is capable of providing. In 1989, the ABVS created a standing subcommittee to encourage the enhanced utilization and availability of specialty services to the veterinary profession and the public. This is a committee to promote specialties and to provide marketing initiatives. Beforehand, the ABVS was constituted to furnish advice and assistance, establish criteria, and evaluate and review applications. Now, the objectives have been expanded to include the promotion and utilization of specialties. In addition, the ABVS wants to have specialty acronyms (eg, ACVIM, ACVS, ACT, ACVO) added to the geographic listing of board-certified individuals in the AVMA Directory. In 1989, the telephone numbers of veterinarians were added to the Directory, which is distributed to all AVMA members. The combination of telephone numbers and specialty designations should make the Directory a universally available resource for consultation and referrals. Finally, the ABVS is on record with the Executive Board and AVMA officers that any marketing and promotional endeavors should include the role of specialization and practicing specialists in the media material.

What about the future? How is the ABVS/AVMA preparing to lead specialization into the next century, hopefully avoiding a disparate conglomeration of adversarial groups? With the intent of retaining the authority for establishing criteria for specialty boards and evaluating petitions for recognition, yet being of assistance, furnishing advice, and promoting and encouraging the utilization and availability of specialty services, the ABVS has approved several new policies and positions in the last 2 years to foster the orderly evolution of new specialties. First, the term "specialist" has been fully defined. Second, the ABVS has reaffirmed the requirements for Charter Diplomate-status in new specialties and has improved the definition of what constitutes the membership of an organizing committee. These 2 changes have been discussed.

Third, it is increasingly apparent that core specialties (eg, medicine, surgery, radiology, pathology) are already in place in the veterinary profession and that new petitions frequently represent subspecialties that could be affiliated with one of the standing colleges or boards. For example, the oncology subspecialty petitioned successfully as an affiliate of the American College of Veterinary Internal Medicine in 1988. To this end, the ABVS has requested that all existing colleges and boards review their position regarding possible future subspecialties and alter their constitutions if necessary. Internal medicine has had an umbrella policy from the outset. The American College of Veterinary Preventive Medicine has recently recognized the subspecialty of epidemiology. In 1988, the American College of Veterinary Microbiologists recognized subspecialties in virology, immunology, and bacteriology/mycology. The American Board of Veterinary Practitioners currently recognizes companion animal, equine, and food animal practices; pending approval by the Council on Education and the House of Delegates this year, they will add dairy practice and feedlot/cow-calf practice. Other colleges are now considering such subdivisions and affiliations.

There are numerous advantages for new specialties to start out as affiliates. It takes money and leadership to write a constitution and petition the ABVS/AVMA for provisional approval, to put a committee structure in place, to establish residency training programs, to accept credentials and examine candidates, and to get the new college or board up and running. Established specialties have these mechanisms in place and are experienced with credentialing. To facilitate affiliations and to help new colleges and boards avoid the early difficulties of organization, the ABVS has established a policy that states that groups of veterinarians considering the formation of a specialty organization must submit a letter of intent at the earliest time, but at least one year ahead of the submission of a formal petition for recognition. After the filing of such a letter, 2 members of the ABVS will be assigned to the group to act as liaison and to instruct the group in preparing the petition. Representatives of the new group will be invited to attend the annual meeting of the ABVS at their own expense, wherein the liaison members will report on the progress of the group toward developing a petition. New affiliates can retain subspecialty status indefinitely. Or, with suitable growth and intensity, they can seek stand-alone status; the American College of Veterinary Dermatology started out as a subspecialty of internal medicine in 1980 and successfully petitioned for independent status in 1986.

The future for specialization in the veterinary profession is very bright. In many people's minds, it is the future, and all veterinarians have a stake in its orderly evolution. The form and function of specialization within the profession must provide quality assurance and be responsive to societal demand, yet befit a small profession with multifaceted responsibilities to a host of constituencies. Henceforth, the planning must be deliberate and the decisions must be wise.

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Reports of Original Studies

Prevalence and geographic distribution of Fanconi syndrome in Basenjis in the United States

Charles H. B. Noonan, DVM, and Jeffrey M. Kay, DVM

***Summary**: A survey was conducted to ascertain the prevalence of Fanconi syndrome in Basenjis and to determine in which geographic regions the greatest number of affected dogs resided.*

A thousand questionnaires were distributed nationally, and 624 (62%) were returned. Through this survey, prevalence, geographic distribution, and breeder involvement were successfully correlated with the overall association of the disease with the Basenji breed.

Ten percent (96/959) of all Basenjis involved in the survey had Fanconi syndrome. Half (50%; 48/96) of the Basenjis affected were between 4 and 8 years old. Seventy-six percent (44/58) of owners of Basenjis with Fanconi syndrome were breeding their dogs, and 93% (52/56) had owned other Basenjis before the survey was conducted. Females outnumbered males (3:1) in frequency of the disease. This ratio reflected the higher breeder participation in the survey, rather than being a true gender predilection for the disease.

Unusual canine breeds often pose a series of challenges for even skilled veterinary practitioners. The Basenji is certainly no exception to this premise; several types of hereditary defects (eg, pyruvate kinase deficiency, Fanconi syndrome[1]) have come to be well-documented. Though the existence of an unusual breed might be nonsignificant quantitatively, the impact of a particular disease, genetic defect, or pathologic condition may be more pervasive than is generally appreciated.

Breeders and owners of Basenjis have become increasingly concerned with the perceived prevalence of Fanconi syndrome in this breed.[a] The purpose of the study reported here was to ascertain the actual prevalence and distribution of Fanconi syndrome in Basenjis.

Materials and Methods

A thousand questionnaires were sent to breeders and owners of Basenjis throughout the continental United States. Six hundred twenty-four (62%) questionnaires were returned. Those surveyed were asked a number of questions concerning their experience with the disease, knowledge of the disease, experience with Basenjis, and involvement with breeding. To obtain the fullest possible response rate, complete anonymity was provided through a group[b] acting independently from the breeder group.

The prevalence of Fanconi syndrome in each state (Fig 1) was determined by the number of affected dogs reported for the entire survey. In addition to Fanconi syndrome, owners and breeders were questioned about several other diseases (eg, diabetes mellitus, chronic renal disease) that are known to have similar clinical signs of disease.

Results

One thousand fifty-one Basenjis were included in the 624 responses returned. Three hundred eighty-five (62%) responses revealed neither Fanconi syndrome nor any other diseases in the dogs. Such results were not unexpected, because approximately 61% (354/582) of these nondiseased Basenjis were ≤4 years old (Table 1). Sixty-four percent (229/358) of those who reported that their Basenji did not have Fanconi syndrome also had not bred their dogs (Table 2). Forty-nine percent (186/377) of this same group had never owned a Basenji other than the dogs reported in this survey (Table 2). However, 57% (221/386) did express an interest in actively breeding their dogs in the future (Table 3). This represents an issue of concern because it indicates that a large segment of those polled may breed affected dogs. Prior to this survey, 40% (156/386) of the owners in this category were unaware of Fanconi syndrome, and 89% (338/378) had never received any information from veterinarians regarding this potential risk to Basenjis.

The best-informed group was people who had Basenjis with Fanconi syndrome; 89% (48/54)

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[a] Coe S, *Basenji Journal*, Newtown, Pa: Personal communication, 1986.

[b] Meriden Research Group, West Hartford, Conn.

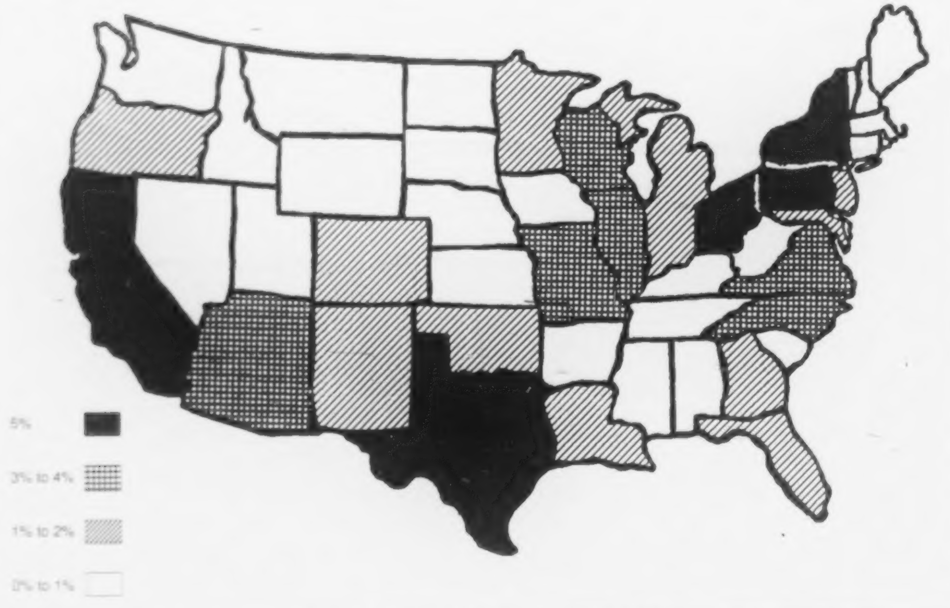

Figure 1—Geographic distribution of Fanconi syndrome and Fanconi suspect in Basenjis in the United States.

Table 1—Ages of all Basenjis included in the survey response

	Age in Years												
Response	1	2	3	4	5	6	7	8	9	10	11	12	Total
No disease reported	92 (16%)	107 (18%)	91 (16%)	64 (11%)	54 (9%)	44 (8%)	27 (5%)	28 (5%)	19 (3%)	17 (3%)	8 (1%)	31 (5%)	582
Fanconi syndrome	8 (9%)	5 (5%)	7 (7%)	15 (16%)	12 (13%)	10 (10%)	4 (4%)	7 (8%)	4 (4%)	5 (5%)	9 (9%)	10 (10%)	96
Fanconi suspect	9 (13%)	10 (15%)	8 (12%)	6 (9%)	3 (4%)	5 (7%)	2 (3%)	4 (6%)	4 (6%)	6 (9%)	2 (3%)	9 (13%)	68
Other diseases	31 (15%)	37 (17%)	18 (8%)	18 (9%)	20 (9%)	7 (3%)	11 (5%)	11 (5%)	12 (6%)	14 (7%)	8 (4%)	26 (12%)	321
													959

Table 2—Quantitative overview of ownership patterns and involvement with breeding

	Have you owned Basenjis other than one(s) reported?		Are you currently breeding Basenjis?		How many Basenjis have you owned prior to this survey?				
Category	Yes	No	Yes	No	1 dog	2 dogs	3 dogs	4 dogs	5 or more
No disease reported	191/377 (51%)	186/377 (49%)	120/358 (34%)	229/358 (64%)	30/151 (20%)	31/151 (21%)	19/151 (13%)	16/151 (11%)	55/151 (36%)
Fanconi syndrome	52/56 (93%)	5/56 (3%)	44/58 (76%)	14/58 (24%)	2/54 (5%)	2/54 (5%)	5/54 (9%)	9/54 (17%)	36/54 (67%)
Fanconi suspect	37/38 (97%)	1/38 (3%)	18/38 (47%)	20/38 (53%)	8 (22%)	3 (8%)	2 (5%)	3 (8%)	21 (57%)
Other diseases	86/122 (70%)	36/122 (30%)	54/123 (44%)	69/123 (56%)	21/81 (26%)	12/81 (15%)	6/81 (7%)	7/81 (9%)	35/83 (43%)

knew of the disease, and 78% (45/58) had discussed the problem with their veterinarian (Table 3). A breakdown of the ages for affected Basenjis is seen in Table 1. Seventy-six percent (44/58) of respondents whose dogs had Fanconi syndrome currently breed their dogs (Table 2); 81% (47/58) of this group indicated that they will continue to breed Basenjis (Table 3). This group was quite consistent in its reporting of clinical signs of the disease usually observed. Females were affected more often than male (3:1). This result can be attributed to the practice of breeders retaining the female offspring for reproductive purposes and should not be misconstrued as a genetically expressed gender predilection of Fanconi syndrome.

The Fanconi "suspect group" was designated

Table 3—General information and background regarding Basenji owners

Question	No disease reported			Fanconi syndrome			Fanconi suspect			Other diseases		
	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure
Prior knowledge of Fanconi syndrome before this survey?	224/386 (58%)	156/386 (40%)	6/386 (2%)	55/58 (95%)	3/58 (5%)	0/58 (0%)	25/39 (64%)	14/39 (36%)	0/39 (36%)	98/128 (77%)	29/128 (22%)	1/128 (1%)
Veterinary consultation if potential clinical signs observed?	27/242 (11%)	212/242 (88%)	3/242 (1%)	48/54 (89%)	6/54 (11%)	0/54 (0%)	23/36 (63%)	12/36 (14%)	1/36 (3%)	108/126 (86%)	18/126 (14%)	0/126 (0%)
Had veterinarian informed you of this syndrome before survey?	38/378 (10%)	338/378 (89%)	2/378 (1%)	45/58 (78%)	13/58 (22%)	0/58 (0%)	7/37 (19%)	30/37 (81%)	0/37 (0%)	39/127 (31%)	86/127 (68%)	2/127 (1%)
Do you breed dogs or would you consider becoming a breeder?	221/382 (58%)	49/382 (39%)	12/382 (3%)	47/58 (81%)	11/58 (19%)	0/58 (0%)	23/38 (51%)	14/38 (36%)	1/38 (3%)	84/126 (67%)	41/126 (32%)	1/126 (1%)
Would you want a quick, inexpensive test for syndrome?	353/388 (91%)	15/388 (4%)	20/388 (5%)	58/58 (100%)	0/58 (0%)	0/58 (0%)	37/40 (93%)	0/40 (0%)	3/40 (7%)	122/126 (97%)	0/126 (0%)	4/126 (3%)

Table 4—Owner observations of clinical signs of disease in Basenjis of the survey

Sign	No disease reported			Fanconi syndrome			Fanconi "suspect"			Other diseases		
	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure
Polydipsia	25/385 (7%)	332/385 (86%)	28/385 (7%)	54/58 (93%)	3/58 (6%)	1/58 (1%)	24/40 (60%)	14/40 (35%)	3/40 (5%)	46/130 (35%)	77/130 (59%)	7/130 (5%)
Polyuria	16/381 (4%)	343/381 (90%)	22/381 (5%)	54/58 (93%)	3/58 (6%)	1/58 (1%)	19/38 (50%)	13/38 (30%)	6/38 (18%)	55/130 (42%)	66/130 (51%)	9/130 (7%)
Inappropriate urination	16/365 (4%)	337/365 (92%)	12/365 (3%)	46/58 (79%)	9/58 (16%)	3/58 (6%)	14/40 (34%)	21/40 (59%)	3/40 (6%)	36/128 (28%)	88/128 (69%)	4/128 (3%)
Polyphagia	34/379 (8%)	335/379 (88%)	10/379 (3%)	8/58 (14%)	45/58 (78%)	5/58 (8%)	6/39 (15%)	27/39 (69%)	6/39 (15%)	37/128 (29%)	83/128 (48%)	8/128 (6%)
Change in coat	52/384 (13%)	324/384 (84%)	8/384 (2%)	40/58 (69%)	18/58 (31%)	0/58 (0%)	19/36 (53%)	17/36 (48%)	0/36 (0%)	75/130 (57%)	52/130 (39%)	5/130 (4%)
Weight loss	42/385 (10%)	336/385 (87%)	7/385 (2%)	46/58 (79%)	11/58 (19%)	1/58 (2%)	21/39 (53%)	17/39 (45%)	1/39 (2%)	62/128 (48%)	65/128 (51%)	1/128 (1%)
Decreased activity	23/381 (6%)	350/381 (92%)	8/381 (2%)	39/58 (69%)	17/58 (29%)	2/58 (2%)	15/39 (38%)	23/39 (58%)	1/39 (4%)	59/128 (46%)	64/128 (50%)	5/128 (4%)

on the basis of comments and observations furnished by breeders and owners. This information was primarily anecdotal; thus, definitive diagnosis of Fanconi syndrome could not be established. However, the considerable number of such responses did warrant a specific category. A comparison of the responses for both categories (Tables 1 and 4) reveals distinct discrepancies between them. In particular, the reported age of onset was quite different, and the owners' observations of clinical signs of disease in dogs listed in the Fanconi suspect category were less consistent with those of the dogs affected by Fanconi syndrome. The suspect category may be partially explained by the nature of Fanconi syndrome, which is that of an infrequently diagnosed disease in an uncommon breed.

One hundred thirty-four responses revealed other important diseases in addition to Fanconi syndrome in the Basenjis of the survey. Among those diseases most frequently described were hypothyroidism (28%, 38/134), diabetes mellitus (9%, 12/134), malabsorption syndrome 9%, 12/134), and urinary tract infections (7%, 10/134). Seventy-seven percent (98/128) of this group was well aware of Fanconi syndrome, yet 68% (86/127) stated that their veterinarian had not discussed the problem with them (Table 3). The number of hypothyroid Basenjis was unusual and may warrant further investigation.

Through results of this survey, the geographic distribution of Fanconi syndrome in Basenjis has been determined (Fig 1). The lack of reports of Fanconi syndrome in Basenjis of a particular state must not be interpreted as that region being free of the disease and may be attributable, in part, to the limited prevalence of the breed in some areas of the country. The 5 states reporting the greatest number of affected Basenjis were California, Texas, Pennsylvania, New York, and Ohio—their sum equaled 40% of the total. The pattern in which the disease disseminates to the contiguous areas of these 5 states was interesting.

Discussion

Since 1976, renal tubular dysfunction (Fanconi syndrome) has been well-documented in Basenjis.[2] In people, the condition of paradoxic glycosuria in association with normal blood glucose concentration was first reported in 1931.[3] Research by others[2-4] has contributed considerably to greater understanding of this pathologic phenomenon.

Transmission of Fanconi syndrome is believed to be genetic (a simple Mendelian recessive trait in people), and can be considered a recessive late-acting lethal gene,[5] because of its appearance in mature Basenjis 3 to 8 years old. Other causes for renal tubular dysfunction in people include Wilson's disease, heavy metal poisoning, neoplas-

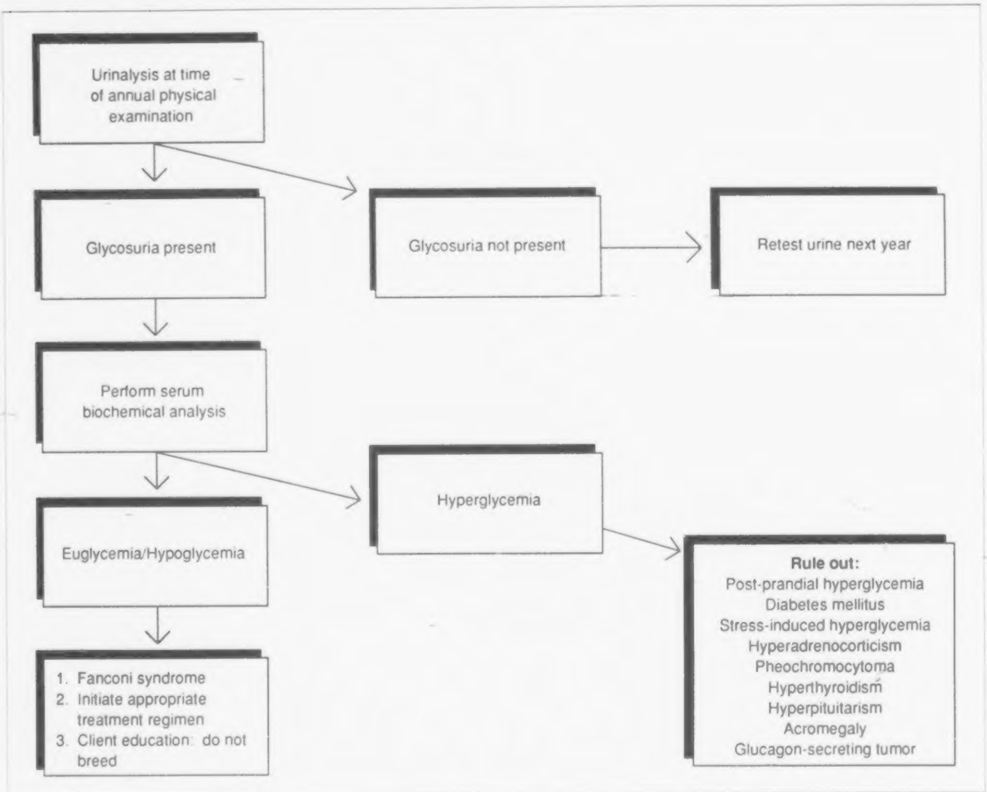
Urinalysis at time of annual physical examination
Glycosuria present
Glycosuria not present
Retest urine next year
Perform serum biochemical analysis
Hyperglycemia
Euglycemia/Hypoglycemia
1. Fanconi syndrome
2. Initiate appropriate treatment regimen
3. Client education: do not breed
Rule out:
Post-prandial hyperglycemia
Diabetes mellitus
Stress-induced hyperglycemia
Hyperadrenocorticism
Pheochromocytoma
Hyperthyroidism
Hyperpituitarism
Acromegaly
Glucagon-secreting tumor

Figure 2—Recommended paradigm for diagnosing Fanconi syndrome.

tic disease, hypergammaglobulinemia, and nephrotic syndrome.[6]

The proximal renal tubules of the kidney perform many functions, including the reabsorption of electrolytes, amino acids, glucose, bicarbonate, and phosphate. The hydrostatic pressure within the glomerulus results in these compounds passing into the tubules.[7] The lack or impairment of this function adversely affects overall homeostasis and will result in a series of distinct physical signs of disease and clinical laboratory findings.

Clinical signs of Fanconi syndrome most often reported in Basenjis are polydipsia, polyuria, dehydration, weight loss in the presence of normal appetite, changes in coat, and decreased activity[2,4,8] (Table 3). Clinical laboratory results usually indicate glycosuria with normal blood glucose concentration, generalized aminoaciduria, proteinuria, hyperphosphaturia, and metabolic acidosis[2,4,8,9] Diseases to be ruled out when considering Fanconi syndrome include diabetes mellitus, diabetes insipidus, and renal disease. The prognosis for dogs with Fanconi syndrome is poor, and affected dogs should be treated similarly as dogs with other types of progressive, irreversible (ie, end-stage) renal failure.[4,9] The diagnostic scheme provided in Figure 2 offers an orderly approach for diagnosing Fanconi syndrome.

The insidious and occult nature by which Fanconi syndrome is transmitted poses considerable problems for breeders and veterinarians. Genetic counseling,[10] cautious breeding, and regular monitoring of the urine for glucose are necessary steps in arresting transmission of this disease. When considering the disease, clinicians should appreciate the importance of achieving a definitive diagnosis through which affected "blood lines" can be identified and continuation of such may be prohibited. Despite the poor prognosis, the breeder/owner should be fully apprised of the necessity for pursuing a thorough inquiry. According to this survey, Basenji breeders and owners will support these efforts and are growing more aware that this is a problem that must be addressed.

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Book Review: Scientific Alternatives to Animal Experiments

This book has been divided into 5 sections, each section consisting of several essays (or papers), the works of 30 authors. The essays were translated and edited from German to English by scholars, using British spellings and idioms. There are about 250 pages with 211 references (105 in English and 106 in German) and 11 pages of elementary medical glossary terms. The book's typeface appears to have been electronically produced and is very small. There are about 20 small illustrations rendered as mediocre line drawings and fuzzy cartoons that are provincial in their humor, if not illustrative of some principle. There are 5.5 pages of index containing about 200 entries.

According to the editor, Dr. Fred Lembeck (MD), there are 2 goals or "aims" for this book: to clarify the role of the animal experiment in modern medical science and to give insight into possible alternative methods to animal experimentation. In my opinion, the book is for a nonscientist audience; indeed, few definitions in the glossary would be needed by any modern veterinarian.

The very title of the book, *Scientific Alternatives to Animal Experiments*, should arouse great interest in diverse (perhaps adversarial) groups that might either be for or against the use of animals for purposes of research in an ongoing controversy. However, for the American veterinarian, regardless of which posture one takes in this controversy, the book falls short of certain contemporary standards expected of professional reference texts. For example, the 30 authors' credentials or institutional affiliations are not cited, leaving their credibility unknown. The rather minimal number of references provided at the end of each of 37 papers in the book would more usefully have been annotated by subject and placed in one section at the end of the book. The index is limited. For example, the page number for the pivotal definition of this book, 'alternative methods,' is not cited in the index at all (it is on page 1 in the introduction).

The basic tenor of the book recognizes the need for animal use in biomedical research, but (perhaps) less assertively acknowledges the historical evolution toward a number of alternative methods that have replaced animals for some kinds of research.

I recommend *Scientific Alternatives to Animal Experiments* for reference libraries at the American high school or junior college level. It should also be of interest to American research veterinarians who wish to compare attitudes toward biomedical animal experimentation in Europe with those in North America.—[*Scientific Alternatives to Animal Experiments, Edited by Fred Lembeck. 247 pages; illustrated. Ellis Horwood Ltd, Chichester, England. 1989. Available in USA from Routledge, Chapman & Hall, 29 W 35th St, New York, NY 10001. Price $74.*]—*Charles J. Sedgwick*

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About the cover

The Dog and Serpent was painted by Rufino Tamayo in 1943. Tamayo, a Mexican-American, abandoned the school of strong nationalism (established by Mexican painter Rivera in the 1920s) for European reference, and was obviously influenced by Picasso and Braque. The painting reproduced on this issue's cover is a good example of why Tamayo is considered to be one of the most exciting contemporary artists in his use of color. His combination of the colors used in native Mexican weaving and crafts, ie, magentas, blues, oranges, purples, and white with vivid reds, accentuates the intensity of his subjects.

Permission to reproduce the *The Dog and Serpent*, a 34 in × 44 in oil-on-canvas, was granted by The Saint Louis Art Museum (Gift of Morton D. May) where the painting is on display.

Coming Soon . . .

October 15

Pages from the Past—Blood transfusion: A historical review (G. Hosgood)

Food for thought for food animal veterinarians—The veterinarian's role in animal welfare (J. B. Herrick)

Hyperkalemic periodic paralysis in horses (S. J. Spier et al)

Distribution of equine infectious anemia in equids in southeastern United States (M. K. Loftin et al)

Patterns of uterine prolapse in dairy cows and prognosis after treatment (I. A. Gardner et al)

Prophylactic use of dantrolene associated with prolonged postanesthetic recumbency in a horse (A. Valverde et al)

November 1

Statistics Simplified—Study design (S. Shoot)

Reflections—Give it your best shot (H. C. Nicoll)

Legal Brief—The liability potential for laboratory animal and public veterinarians (H. W. Hannah)

Topics in Drug Therapy—Pharmacologic features and physiologic effects of dopamine (G. Hosgood)

Special Commentary—Veterinary services for animal use in the United States: A conflict of paradigms (R. S. Ott)

Effect of nonthyroidal illness on serum, thyroxine concentrations in cats (M. E. Peterson and D. A. Gamble)

Iatrogenic fractures of ribs and vertebrae during delivery in perinatally dying calves (G. Schuijt) remaining collateral sources can then drain into the maxillary and major palatine arteries. The latter are substantial vessels, with large subsidiary arterial systems,[6] and could drain off or steal a considerable amount of collateral flow that reaches the external ophthalmic artery.[5] Apparently, any compensatory increase in forward flow to the eye is insufficient to restore blood lost through the steal.[5] Ischemia and blindness follow.

With the balloon catheter technique, the maxillary artery is fully occluded at the origin of the external ophthalmic artery so that a steal phenomenon is prevented. As a result, all or most of blood flow from collateral channels that enters the external ophthalmic artery flows to the eye. Simultaneous occlusion of the internal carotid artery does not appear to increase the risk of blindness with this procedure.[3]

The preceding is based largely on speculation, but is consistent with clinical observations and with explanations for steal syndromes in human beings.[5] Although the balloon catheter technique that we have described is more difficult than ligation procedures, it has the advantage of isolating the infected segment of artery from as many collateral channels as possible, apparently without jeopardizing blood flow to the eye.[3] Nonetheless, owners should be warned of the possibility of unilateral blindness following any technique for occlusion of the external carotid artery and its branches within the guttural pouch.

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Michael W. Ross, DVM
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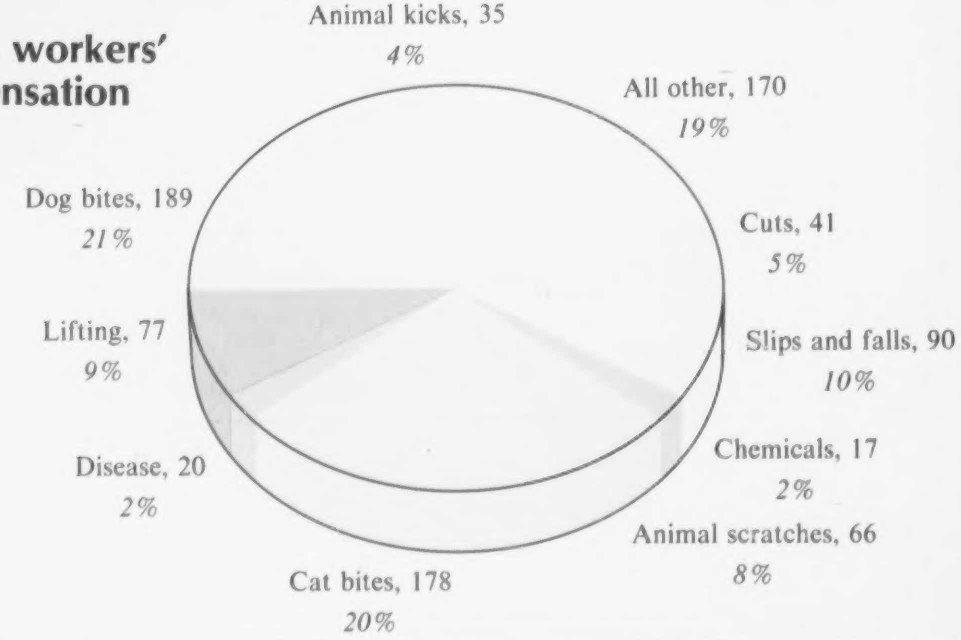
Workers' compensation policies cause confusion

AVMA workers' compensation losses



The above chart, covering losses from July 1989 through July 1990, illustrates the categories of losses, the number of losses in each category, and the percentage of the total these losses represent.

Many veterinarians have called the AVMA Group Health and Life Insurance Trust office to ask whether it is necessary to carry workers' compensation insurance coverage when they already provide accident and health insurance to their employees through the Trust.

Although workers' compensation laws vary from state to state, most states require employers to carry such insurance for their employees. Employers who do not comply are subject to fines and civil penalties.

Many veterinarians believe that anytime an employee gets injured, whether on or off the job, the group health insurance will provide complete coverage for the claim. However, medical expenses for on-the-job injuries or illnesses for which individuals are entitled to benefits under a workers' compensation act or similar law will not be covered by the Trust's major medical policy. This means that if an employee is injured on the job and is covered by workers' compensation insurance, the medical expenses will be considered ineligible by the AVMA's major medical carrier.

In most states, employers have the option of including or excluding themselves from workers' compensation coverage. However, other states require an employer to be excluded from or included in the workers' compensation coverage, depending on the type of business entity. If a veterinarian employer elects to be covered under a workers' compensation policy, that veterinarian would receive medical expense benefits under workers' compensation; again, these benefits would not be paid under the AVMA major medical plans.

Veterinarians with questions can call the Trust office and speak with representatives from either the Trust or the AVMA Workers' Compensation program.

Workers' compensation losses

Atlantic Mutual Companies, the insurer for the AVMA Workers' Compensation and Professional Liability insurance programs, has produced statistics on the type and frequency of reported claims for workers' compensation. These statistics cover a one-year period, from July 1989 through July 1990. These numbers help identify potentially dangerous activities of which members should be aware to help reduce the frequency and severity of injuries. Of 15 cause-of-loss categories, cat and dog bites topped the list—contributing more than 40% to total losses. They accounted for 368 of a total 883 claims. The amount paid out for dog and cat bites was $294,745 (26% of the total). The category that contributed the next highest amount of claims was "slips, trips, falls—on premises." There were 82 such losses, accounting for 9.2% of the total. This translates into $220,861 or 19.5% of the total amount paid.

Many animal bite claims could be avoided by using protective devices such as muzzles or gloves. Likewise, slips and trips can be avoided by using rubber mats over wet floors and taping down loose edges of carpeting or electrical cords.

The AVMA Professional Liability Insurance Trust, in conjunction with Atlantic Mutual Companies, has produced a safety poster to help educate employees on how to reduce potential losses. Veterinarians who would like this poster should call Michele McDevitt at the Trust's new toll-free number, 1-800-228-7548. Information about Professional Liability or Workers' Compensation insurance may also be obtained from the Trust.

Prepared by Michael J. Ahlert of Mack and Parker, Inc, Chicago, on behalf of the AVMA Professional Liability Insurance Trust.

Trust office adds toll-free number

The AVMA Professional Liability Insurance Trust office introduced a new toll-free telephone number and mailing address for veterinarians inquiring about their Professional Liability and Workers' Compensation insurance policies. The new number is 1-800-228-7548 (1-800-228-PLIT). The new address is PO Box 1629, Chicago, IL 60690-1629. This change went into effect Sept 17, 1990.

The new telephone number, to be used exclusively for veterinarians who carry Professional Liability or Workers' Compensation insurance coverage, will minimize the waiting time to make coverage changes or ask questions. Additional lines will be opened to better serve insured members.

The AVMA Group Health and Life Insurance Trust will continue to use its current toll-free number and mailing address: 1-800-621-6360, and 55 E Jackson Blvd, 8th Floor, Chicago, IL 60604.

Technicians Today

Dietitian award announced

Beginning with the 1990 competition, two recipients will be chosen for the Small Animal Clinical Dietitian Award from Hill's Pet Products.

One award will be made to a veterinary technician who has graduated from an AVMA-accredited veterinary technology school or who has earned this title by being certified, licensed, or registered. The other will be made to a veterinary hospital staff member.

Each of the two winners will receive a plaque, a check for $1,000, and an all-expense-paid trip to the 1991 Western Veterinary Conference in Las Vegas. Entry forms are available from Veterinary Affairs, Hill's Pet Products, 400 SW 8th St, Topeka, KS 66603. Entries must be received by Nov 1, 1990. For more information, contact Janet Grace, LVT at Hill's, 1-800-255-0449.

Convention Spotlight

Honor roll . . . from 825

Dr. Alexander E. Whaley, Kissimmee, Fla
Dr. Roland G. Whitehead, Springville, NY
Dr. Alexander T. Wiatt, Hampton, Va
Dr. J. D. Williamson, Clarksville, Mo
Dr. Stanton Williamson, Brownsburg, Ind
*Dr. T. Ellsworth Willis, Honesdale, Pa
Dr. Charles W. Wincey, Orlando, Fla
Dr. John K. Winkler, Auburn, Ala
Dr. Roland W. Winterfield, West Lafayette, Ind
Dr. R. George Wiswall, Glens Falls, NY
Dr. Arthur H. Wolff, Washington, DC
Dr. Robert P. Worthman, Camano Island, Wash
Dr. Leo A. Wuori, Guyton, Ga
Dr. Robert M. Young, Osage, Iowa
Dr. Theodore Zimmerman, Palm Beach, Fla

**Recently deceased; see page 832 for obituaries on Drs. Leo R. Wempe and T. Ellsworth Willis.*

October 15, 1990, Volume 197, Number 8

JOURNAL

OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

Bloomfield Horses, 1988

Joan Anderson

JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION

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Correction

In the August 15 issue of the JAVMA, the letter "Encourages new services to replace tube deworming" was not included in the Table of Contents. The letter appeared on pages 441–442. The JAVMA regrets the error.

Cover artist

Mrs. Joan Anderson is the wife of Dr. Raymon A. Anderson, a large-animal practitioner in Pierce, Neb.

Coming Soon . . .

November 1

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Distribution of equine infectious anemia in equids in southeastern United States

Martha Kathlynne Loftin, DVM; Jay F. Levine, DVM, MPH; Tom McGinn, DVM;
Leroy Coggins, DVM, PhD

Summary: *State veterinarians in 11 southeastern states completed a questionnaire designed to determine the proportion of equids in the region that were seropositive for equine infectious anemia (EIA). Cases of EIA were diagnosed in each of the states surveyed. Distinct geographic clusters of cases were apparent in Tennessee and Kentucky adjacent to the Mississippi River, in the Piedmont of North Carolina at the Virginia border, in north central Georgia, and throughout the Florida peninsula. It is suggested that the national EIA program could be improved by standardization and wider application of uniform active surveillance measures, and improved documentation of EIA status of horses on acquisition and transfer records.*

Equine infectious anemia (EIA) is a disease with protean clinical manifestations that affects members of the genus *Equus*. A small percentage of affected equids develop fatal viremia; those that survive experience a chronic relapsing illness or become persistent carriers (without clinical signs of infection) of the virus.[1] The malady is caused by a retrovirus that has unique variable antigenic properties.[2] Transmission of the virus requires direct blood transfusion, either by biting insects or other mechanical vectors such as contaminated needles.[3] Equine infectious anemia has been associated with mortality in equids in Africa, Asia, Europe, and North and South America. In the United States, sporadic episodes of EIA have been recognized since 1896.[4]

In the United States, EIA is a reportable disease.[5] If an equid is seropositive for EIA, it is prohibited from crossing state lines without permission from federal and state authorities. The USDA maintains a record of all reported positive test results. The objectives of the study reported here were to determine the annual proportion of equids testing positive for EIA within southeastern United States between 1984 and 1987 and to compare intrastate control programs of the states within this region.

Materials and Methods

To obtain information about EIA testing activities, a questionaire was sent to state veterinarians in 11 southeastern states. Information that was obtained included the number of equids tested for EIA, the number seropositive for EIA, and the num-

Table 1—Cases of equine infectious anemia (EIA) in southeastern United States during 1984-1987

State	Year	Percentage of population tested*	EIA test results No. tested	No. positive	Percent positive
Alabama	1985	0.07	8,399	44	0.52
	1986	0.11	19,145	67	0.35
	1987	0.18	22,183	114	0.51
Florida	1984	0.18	68,449	362	0.53
	1985	0.19	71,659	369	0.52
	1986	0.19	79,739	372	0.47
	1987	0.22	87,976	448	0.51
Georgia	1984	0.03	14,789	45	0.30
	1985	0.03	18,434	48	0.26
	1986	0.08	22,008	107	0.49
	1987	0.12	37,724	168	0.45
Kentucky	1987	0.02	63,347	68	0.11
Maryland	1984	<0.01	23,633	1	0.01
	1985	0.01	24,566	7	0.03
	1986	<0.01	22,902	2	0.01
	1987	0.01	24,122	5	0.02
Mississippi	1987	0.17	16,059	330	2.06
North Carolina	1984	<0.01	8,856	8	0.09
	1985	<0.01	9,556	4	0.04
	1986	<0.01	9,375	5	0.05
	1987	0.02	10,623	35	0.33
South Carolina	1984	0.03	7,578	25	0.33
	1985	0.02	7,591	15	0.20
	1986	0.01	7,974	8	0.10
	1987	0.02	5,630	18	0.32
Tennessee	1984	0.05	12,816	112	0.87
	1985	0.03	13,629	68	0.50
	1986	0.05	10,923	101	0.93
	1987	0.07	16,416	151	0.92
Virginia	1984	0.02	31,508	20	0.06
	1985	0.01	33,107	15	0.05
	1986	0.01	21,421	10	0.05
	1987	0.01	33,455	12	0.04
West Virginia	1984	<0.01	5,792	0	0.00
	1985	<0.01	6,150	1	0.02
	1986	<0.01	6,717	0	0.00
	1987	0.02	6,880	6	0.09

*Percentage of estimated equine population tested, base year 1987.

From the Department of Microbiology, Pathology, and Parasitology, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough St at William Moore Dr, (Loftin, Levine, Coggins), and Veterinary Division, North Carolina Department of Agriculture, PO Box 27647 Raleigh, NC 27611 (McGinn). Address reprint requests to Dr. Levine.

Resources used to support this research were provided by the State of North Carolina.

We thank the state veterinarians for their cooperation in making this study possible.

Table 2—Breed distribution of EIA cases diagnosed in three southeastern states during 1984-1987

	Alabama		Kentucky		North Carolina	
Breed	**No. of cases**	**Percent of total**	**No. of cases**	**Percent of total**	**No. of cases**	**Percent of total**
Appaloosa	5	4.4	3	4.4	...	...
Grade	3	2.6	—	—	5	14.3
Mule	11	9.7	7	10.3	...	...
Quarter Horse	42	36.9	33	48.5	12	34.3
Saddlebred	2	1.7	13	19.1	...	...
Tennessee Walking Horse	7	6.1	2	2.9	5	14.3
Thoroughbred	2	1.7	1	1.5	12	34.3
Other	42	36.9	9	13.3	1	2.8
Total	114	100.0	68	100.0	35	100.0

ber of equids in the state during 1984-1987 (Table 1). In addition, the breed, gender, and age of each equid tested were requested. A copy of each state's current intrastate law and enforcement policy with the date they took effect also was obtained.

The proportion of equids testing positive for EIA in each state was calculated for each year information was provided. The states were classified as having active, passive, or no intrastate law regulating control of EIA. Active intrastate laws were defined as laws that were enforced to some degree by state officials or accredited veterinarians. Passive laws were defined as laws that were enforced principally by the industry. The association between the magnitude of regulatory efforts and the number of EIA cases reported was evaluated.

Results

Eleven questionnaires were distributed; all were returned. Ten states provided information about the actual number of new cases diagnosed (Table 2). One state, Florida, did not differentiate between previous known reactors that were retested and new cases of EIA. The surveillance data collected were incomplete; Mississippi and Kentucky did not have EIA case information prior to 1987, and Alabama did not compile case information during 1984. Alabama, Kentucky, and North Carolina provided specific demographic case data for 1987. Equine population figures were provided by each state; however, the manner in which census information was obtained was variable.

Equine infectious anemia was diagnosed in equids in each of the states surveyed (Table 1). The proportion of equids testing positive for EIA was greatest in Mississippi, where 2% of those tested seropositive, but did not exceed 1% in the other states. North Carolina was the only state that had an obvious increase in the proportion of cases, which ranged from < 0.05% in the years prior to 1987 to 0.33% in 1987. Testing activity steadily increased in Alabama, Florida, and Georgia over the 4-year period; little fluctuation in testing activity was evident in the remaining states.

Equine infectious anemia was widely reported throughout the Southeast (Fig 1). Clusters of more than 10 cases were evident in 6 states. Prominent foci of cases were evident in western Kentucky and

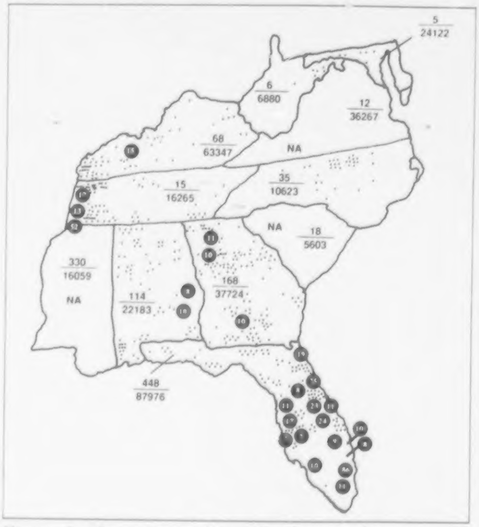

Figure 1—Proportion of equids that tested positive for equine infectious anemia (equids testing positive by the agar gel immunodiffusion test/No. of equids tested) during 1987 in 11 southeastern states. Black circles represent clusters of seropositive equids reported from one locality. NA = Map not available.

Tennessee in counties bordered by the Mississippi River, in the Piedmont area of North Carolina at its Virginia border, in northwestern Georgia, and in south central and northeastern corners of Flordia.

The laws governing the control of EIA in the Southeast varied from state to state. Alabama, Flordia, Georgia, Maryland, Kentucky, and Virginia had active intrastate laws. Since November 1981, Alabama has had an active intrastate law aimed at controlling the spread of EIA. Proof of EIA seronegative status was monitored at state fairs, auctions, and roadside. Florida has had an active intrastate policy for the control of EIA since October 1973. Test results were examined by state officials at the state lines and prior to participation in shows, fairs, and horse auctions. Since January 1987, Georgia required that negative EIA test results accompany each equid to shows, rodeos, trail rides, and public boarding and training facilities. Blood samples were drawn from equids at auctions if proper proof of seronegative status was not available. Kentucky's control program focused on auctions and fairs. Equids sold at consignment auctions were serologically tested prior to being sold. Sale barns were approved on the basis of ability to keep accurate records of the origin and destination of each equid. Blood samples were obtained from equids at these auctions. Maryland's control program was revised in January 1987 and provided for stricter control of auction markets. Since November 1985, Virginia has required that auctions employ a licensed veterinarian to collect blood samples to be submitted for EIA testing.

South Carolina and West Virginia had passive intrastate laws focusing on auctions and fairs. South

Carolina's law has been in effect since February 1978. Most of the enforcement was handled by the industry; however, state veterinarians have worked with the highway patrol to decrease the interstate transportation of equids into the state without proper proof of negative EIA status. West Virginia's law has been in effect since 1987 and has depended on industry compliance for enforcement. Neither Mississippi, North Carolina, nor Tennessee had an intrastate control program.

State veterinarians from Alabama, Kentucky, and North Carolina provided information about individual cases identified in 1987. Quarter Horse was the most frequently affected breed (Table 2). The age and gender of equids with EIA were provided by Alabama and Kentucky, but were not routinely recorded by other state agencies.

Discussion

Equine infectious anemia continues to be sporadic within the United States and has been diagnosed in all but 5 states.[6] In 1973, EIA became a reportable disease in the United States.[4] The national program is limited to the control of interstate trafficking of reactors. State regulatory agencies have retained the responsibility for testing and case surveillance. The monitoring strategies used have not been standardized, and this variation impedes efforts to assess the actual prevalence of the disease in the United States. In Canada, a national control program was instituted in 1971. Equids were tested on an owner voluntary basis unless the disease was suspected, at which time testing became mandatory. Diminished spread of the disease was attributed to this active program.[7]

Within each state, the proportion of equids testing positive by use of the agar gel immunodiffusion test provides a crude estimate of the number of equids with EIA. However, it is impossible to determine when these equids became infected. In addition, the USDA's system of data collection does not account for the number of equids that have been retested and further clouds the ability to accurately determine the prevalence of the disease. In this study, testing activity, as a percentage of the equine population, increased in Alabama and Florida over the 4-year period. In North Carolina, the relative percentage of equids testing positive increased during 1984 through 1987. This increase possibly represents an artifact of testing and case surveillance efforts. Recognition of one clinical case precipitates increased levels of testing in areas in which equids would not have been screened otherwise, and the reverse also may be true. If high-risk populations are not included in a surveillance program, episodes of EIA may be missed.

Cases were broadly distributed throughout the states surveyed. Obvious trends did not exist in the number tested or number of cases relative to state laws. Most cases reported were in equids ≥ 8 years old; however, insufficient case and population information was available to accurately assess the age distribution of affected and nonaffected equids. In a Canadian study conducted during 1981, age of seropositive equids was 7 to 8.5 years.[7] Mean age of seropositive equids intuitively reflects the chronicity of EIA virus infection, but may simply reflect the actual age distribution of equids in the Southeast and the Canadian study area.

Equine infectious anemia is a disease that can cause devastating economic and personal losses.[4] Standardization of record keeping between states would eliminate some of the current problems that impede efforts to assess the effectiveness of EIA control programs and facilitate further characterization of the distribution of the disease. Specific recording changes that would improve program evaluation include: differentiating between equids tested for the first time and those being retested; adaptation of a uniform test chart; recording the reason for testing (eg, sale); and recording the geographic location of cases in individual counties and on farm premises. Demographic information about known reactors and nonreactors within the same geographic area would provide useful information for evaluating the risk factors that predispose equids to infection.

Continued case surveillance is needed to document the temporal and spatial distribution of EIA. The national EIA program could be improved by adopting uniform active surveillance at all public horse events, sales, and auctions by each state, documenting EIA status prior to transfer of equid ownership, and acquiring the site-specific case information needed to assess the geographic distribution of EIA. A national equine census would provide accurate population data for estimating local incidence of EIA and monitoring its spread. The successful implementation of control measures to minimize the impact of the disease on the equine population will ultimately be determined by the support offered by the equine industry and the effectiveness of state surveillance activities.

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